Tab. A.

Fig. 1.

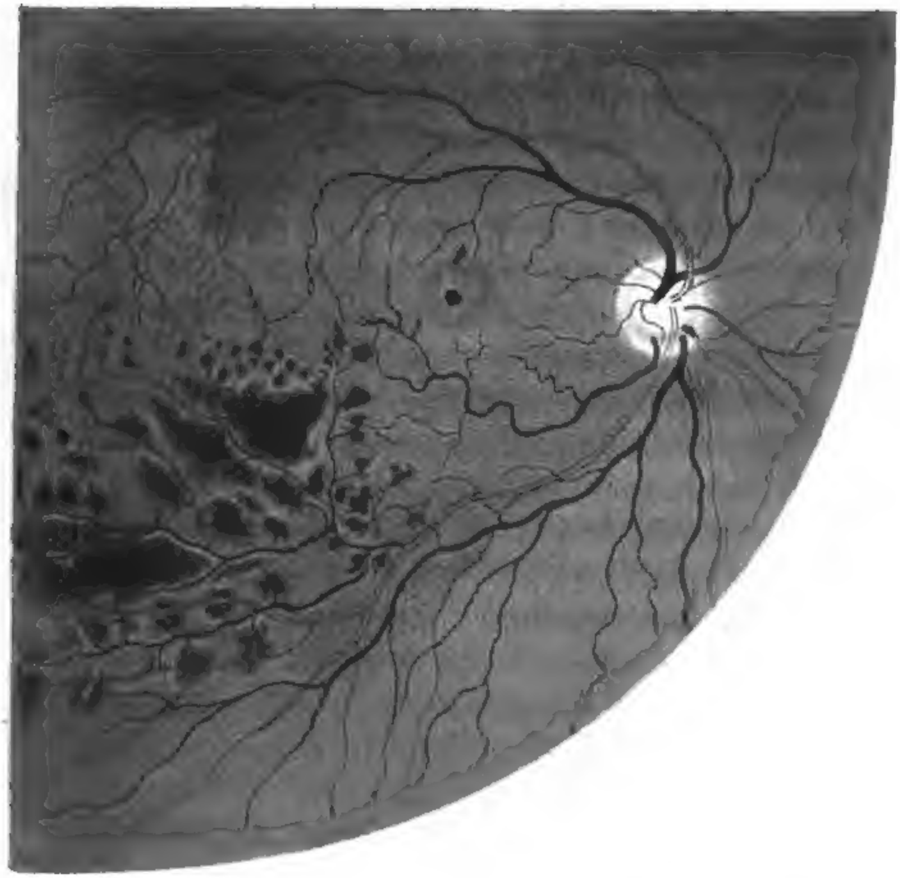

Fig. 2.

Fig. 3.

Fig 1 H Knapp ad nat del

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ARCHIVES

OF

OPHTHALMOLOGY

AND

OTOLOGY.

EDITED AND PUBLISHED SIMULTANEOUSLY IN ENGLISH AND GERMAN.

BY

PROF. H. KNAPP, M.D., IN NEW YORK,

AND

PROF. S. MOOS, M.D., IN HEIDELBERG.

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CONTENTS.

PROSPECTUS.

The physiological connection between the organs of sight and hearing has at all times been deemed by eminent naturalists a good reason and a powerful incentive for extending their investigations over both the eye and ear, and the late researches of Professors *M. Schultze* and *H. Helmholtz* are but another and a most brilliant illustration of this truth.

The wide field of scientific exploration, opened by the invention of the ophthalmoscope and the discovery of many other methods of physiological and anatomical inquiry, led to so many questions of practical application that the most talented and persevering medical men found ample occupation in the study and practice of either ophthalmology or otology. By this division of labor an unexpectedly rapid progress was achieved in each of these departments, which now begin to be so well defined and understood that, henceforth, a conscientious student will hardly be satisfied with limiting his knowledge to one single organ, but will, on the contrary, by reason of the many analogies between them, irresistibly be led from ophthalmology to otology, or vice versa, yielding to the same influences and reaping the same

benefits as anatomists and physiologists, the vanguard of physicians, did at an earlier date.

But, aside from the natural affinity of these two branches, it will be proper to remember that, the number of oculists having so much increased during the last decade, it will not be wise for the younger generation to rely with too much confidence on ophthalmic surgery exclusively.

Literary production, especially that in scientific periodicals, is a true reflection of the scientific attempts and achievements in the theoretical as well as practical field. Whenever the discovery of new sources of investigation suddenly attracts a superabundant amount of intellectual activity toward one special branch, there will at once spring up a luxuriant growth of special literature, and, when these sources prove to be inexhaustible, and the results of the scientific labor bestowed upon them admit of an extensive practical application, then this special literature will not be ephemeral, but take lasting root and grow vigorously.

These observations of a general character will naturally lead to a *survey of the present state of ophthalmology and otology.* We should be bold indeed, if we were to expect from the next two decades so many brilliant discoveries as the last two have given to the scientific world. Nevertheless, research in ophthalmic as well as in aural surgery is still necessary, productive, and full of promise. A great many questions yet remain unanswered; many morbid and even physiological conditions have to be elucidated; and most, we might say all, the results of

modern science in these two specialties are yet of so recent a date, that it would be difficult to denote any one point which might not profitably be subjected to renewed searching scrutiny.

When, as we have set forth, the close relationship between ophthalmology and otology, the present greater facilities of acquiring thorough knowledge in both, and the increasing number of oculists, *render the combination of ophthalmic and aural surgery most advisable*, then we must consider the publication of these Archives as being not only justifiable, but highly opportune. *In America they may be looked upon as an actual necessity*, since in the whole of this vast and rising country no journal either of ophthalmology or otology exists.

The relations of different peoples, growing from year to year freer and more intimate, correspondingly divest most branches of science of their national physiognomy, rendering them a boon common to all. What was prepared or detected in one country, is refined and developed in the other, and brought to practical and general application in the third.

In consideration of the true *international character of medical science*, the Editors have decided to publish the "Archives of Ophthalmology and Otology" simultaneously at New York and Carlsruhe, in the English and German languages. Contributors will not fail to appreciate the unusual advantage of having their discoveries and researches immediately promulgated in the two most wide-spread idioms of the civilized world.

The purpose of this periodical is not only to diffuse

knowledge among the medical profession, but to act as a stimulus for scientific investigation. Ophthalmic and aural surgeons will promote their own interest and that of science by publishing the results of their studies and experience in a *special organ*, for many valuable observations are apt to be overlooked and lost when scattered among the diversified contents of general medical journals.

The "Archives" will be open to *original communications* only, relating either to the pure anatomy and physiology, or to the pathology and therapeutics of the organs of sight and hearing. Every article should be written in such a way that its length will not be disproportionate to the amount of new and instructive material furnished by it.

The "Archives of Ophthalmology and Otology" will appear in the form and size of this Prospectus, and be printed on the same quality of paper. No expense shall be spared in the matter of woodcuts, lithographs and chromo-lithographs. It is the intention of the Editors to issue the "Archives" half-yearly, in spring and autumn, by separate independent numbers, each to contain about 250 to 300 pages, and two numbers to form a volume.

The Editors congratulate themselves on being able to announce that a great many most eminent ophthalmologists and otologists, both of Europe and the United States, have expressed a deep interest in, and promised their active co-operation with the objects of these Archives. The different places of residence of the two

Editors will, in the present state of the transatlantic mail-service, occasion no delay in the publication of a work in semi-annual numbers.

Communications—which are respectfully solicited—may be addressed to either of the undersigned Editors.

PROF. H. KNAPP, M.D.,
No. 25 *West* 24*th Street, New York.*

PROF. S. MOOS, M.D.,
Heidelberg (*Germany*).

The publishers take pleasure in announcing that the first number of the "Archives" will be issued some time in May, and will consist of about 300 octavo pages of entirely original matter, contributed by men of eminence in this country and in Europe; fully illustrated by fine engravings and superb chromo-lithographic plates.

The second number will appear about six months thereafter, the two numbers forming one very handsome volume, replete with articles of standard value, not only to the professed ophthalmologist and otologist, but also to the general practitioner.

As the number of plates imported from Germany for the first number is not large, the edition will be limited, and those who desire to subscribe should at once send their names and addresses, accompanied with the subscription price, to

WM. WOOD & CO., *Publishers*,
NEW YORK.

Subscription price $7.00 per annum, in advance.

ENTOPTIC PHENOMENA CONNECTED WITH THE CIRCULATION OF THE BLOOD.

BY B. A. POPE, M. D.,

Lecturer on the Eye and Ear in the University of Louisiana, New Orleans.

IN looking through a dark-blue glass at a bright sky numerous luminous figures in rapid motion appear over the whole field of vision, except in a small space at its center. Their movements are independent of those of the eye. The number of these bodies appearing in a given space varies very much at different moments. Their typical form is that of the letter S, though many never reach it, and some few even appear only for an instant, and then simply as luminous points. They are of a brilliant white, the degree of which, however, varies in the different figures. Continuous with and following the luminous band is a shadowy portion, the distinctness of which also varies.

Attending the motions of these bodies in my eye there is a *distinct* and *regular pulsatory movement coinciding* with

the pulse at the *wrist*. This is best observed when the figures are very distinct, and the attention is not too much concentrated upon any one portion of the field of vision. The pulse is marked by the sudden and uniform increase in the rapidity of the movement of the luminous bands.

In performing this experiment, I have found it best to *close* and *cover* one eye.

Simultaneously with the *luminous bands* I have been able to observe the appearance of *currents* (disks), which two phenomena seem to be projected in different planes; the *luminous bands* appearing to be nearest the eye. In performing this experiment, I first brought into view the currents, and then suddenly placed a blue glass before the eye. Both of these appearances are, however, best observed separately.

Both the luminous bands and the currents or disks have been described by *Vierordt*, *Meisner*, *Ludwig*, *Helmholtz*, and others. *Vierordt*, who seems to have seen the currents very plainly, brought them best into view by gazing on a highly luminous surface for a short time, and then rapidly passing the separated fingers from side to side, between the luminous surface and his eye. The appearance of currents is caused by innumerable disks moving uniformly in fixed paths. When observed by me, upon looking at a highly illuminated surface, the disks are white or yellow, or some are white and some yellow. When the disks are projected upon a slightly luminous white surface, they are of a luminous grayish white. They are always a mixture of blue and yellow when observed through a blue glass, or when a

blue glass or blue card is passed rapidly from side to side, between the eye and the luminous surface.

I have not been able to convince myself that there is any *interruption* in the *currents at* the *point* of *fixation*. One difficulty in the way of accurate observation is the blinding effect of the light, which is most decidedly felt at the macula lutea.

By looking upon a highly luminous surface, and passing the open fingers rapidly from side to side between my eye and the light, the disks in motion first appear, then they seem tc form currents not distinctly bounded, and at last the whole field darkens, commencing at the center, and becomes mapped out into disk currents and interspaces. The interspaces occupy comparatively but a small space. After repeating this experiment a few times, the eye becomes much fatigued, and the central portion of the field remains darkened for some time, so as to interfere very much with the use of the eyes. This is principally the case with my right eye.

By simply looking at a slightly illuminated white surface, and allowing the light from a brilliant lamp, placed a little to one side and nearer the eye, to fall upon the retina, the currents appear in my eyes, especially in the left, with great ease and distinctness. It facilitates very greatly the production of the currents if, instead of fixing the attention upon the surface upon which they are projected, I gaze at a point far beyond; still this is not absolutely necessary, for to a great extent their appearance is independent of the state of the accommodation. If my eye be accommodated

sharply for a point upon the surface upon which the currents have been projected, they do not seem to reach the center of the field, and at times I can voluntarily vary the diameter of this space free from the currents, without any seemingly great change in the condition of the accommodation. It is quite easy to make this central deficiency of the currents disappear. At times the currents appear to me by looking simply at a moderately illuminated white surface. Frequently when the whole field of vision is darkened and mapped out into currents, they *suddenly* disappear entirely, and with their disappearance there is a cessation of the feeling of strain and of effort. Complicating these experiments, and rendering the influence of the state of the accommodation upon the production of the currents uncertain, is the fact that I find the covered eye deviated inward, when the currents are seen in their greatest perfection. I am almost certain that the sudden disappearance of the currents, which frequently occurs in my right eye, is connected with the sudden cessation of this strabismus. Upon this fact also seemingly depends the feeling of strain and of effort felt during the experiments. The feeling of strain is generally in the eye used. The fact that one eye is better adapted to the performance of these experiments probably depends, at least in part, upon the greater ease with which this strabismus internus is produced in one eye than in the other. Frequent pressure of the eyeball with the lids seems to favor the performance of the experiment.

At times slight pressure upon the closed eyelids turned from the light brings again into view the currents in a re-

markably distinct manner ; but this seems to be an exceptional occurrence.

By looking through a small opening in a card at a highly illuminated surface, and making slight movements of the card, the finest retinal vessels entoptically visible, appear to me with remarkable distinctness. At the same time, by increasing the movements of the card, the currents appear in an *entirely distinct* and *more remote plane.* Of course the two phenomena can not be seen at the same time in the greatest perfection of each ; but it is easy to determine, that without doubt the phenomenon of currents has nothing whatever to do with what transpires in the finest visible retinal vessels running to the macula lutea. While observing these two phenomena, the apparent size of the corpuscles is larger than that of the smaller vessels, and the currents appear much larger than do the largest vessels in the neighborhood of the macula lutea, In this experiment, also, I can not see that the currents are deficient at the point of fixation. At times there is an apparent deficiency, seemingly growing out of the blinding effect of the light.

Only in the experiment first mentioned, have I been able to observe the currents (disks) and the luminous bands simultaneously.

The capillary circulation, visible entoptically in the form of currents, takes place in a plane nearer to the percipient layer of the retina than are the finest retinal vessels entoptically visible. This fact can only be explained, by assuming either that a layer of capillary vessels exists in the retina nearer to the percipient layer than the finest retinal ves-

sels entoptically visible, or that the currents depend upon the circulation in the choriocapillaris. Moreover, if there be in reality no interruption in the currents in the central portion of the field of vision, it is necessary to seek their cause in the choriocapillaris. The latter is nearer to the percipient layer of the retina than are the retinal capillaries, but this fact does not throw much light upon the subject in the present state of our knowledge. It does not seem impossible, that by illuminating the choroidea and sclerotica, objects placed immediately behind the retina might become entoptically visible, especially if there should be a deficiency in the amount of pigment in the choroidea.

As has been already remarked, it seems to me that the luminous bands appear in a plane nearer the eye than do the disks. The proof that the causes of these two phenomena lie in different planes does not depend upon this observation alone; for it has been experimentally proven by *Helmholtz*, that the luminous bands must be placed in connection with the circulation in the retinal vessels entoptically visible; while one of the above-described experiments demonstrates the total want of connection between the visible retinal vessels and the currents.

Helmholtz explains the appearance of the luminous bands by supposing that temporary interruption to the circulation in some of the retinal capillaries occurs, caused by the larger blood globules blocking the blood channels, and causing collapse of the capillaries in front and accumulation of blood globules behind. The brilliant portion of the figures, he thinks to be caused by the collapsed portion of

the vessel, and the shadowy portion by the accumulated blood globules.

That the appearance of disk currents can not receive the same explanation, seems highly probable from the following summary of facts, as observed in the experiments made with my eyes.

The luminous bands are best seen by softening the light by means of a deep-blue glass, and by closing and covering one eye, while looking, *without effort*, at a light sky. The currents are best seen by looking at the luminous surface, or upon a surface to one side of the strong light, without a glass, one eye being covered, but not closed.

In covering the eye, it should not be *totally excluded* from the *entrance of light*, but simply excluded from taking direct part in the experiment, a certain amount of light being allowed to enter from the sides. I have frequently observed, that when the currents were most perfectly seen, they could be made to disappear immediately by cutting off the light as far as possible. Frequently, after causing the currents to disappear in this manner, they would return at once to view upon allowing a little lateral diffused light to enter. These facts are especially well observed in the experiment where the disk currents are projected upon a moderately illuminated, slightly roughened, white surface.

Instead, however, of looking at the luminous surface without effort, I find it best to look toward it, but as though looking as far as possible beyond, with an effort that causes strabismus internus in the covered eye, and a decidedly unpleasant feeling of strain, especially in the eye used. The

luminous bands disappear upon ceasing to look upon the luminous surface, while the currents may appear some time after the experiments have been made, and this too with the eyes closed and turned from the light. The luminous bands are *isolated*, whereas numerous *disks* pass along the *same* path. The luminous bands appear and disappear suddenly, and return again at the same point at irregular intervals of time, while the currents never intermit, and the individual disks only disappear by passing beyond the point of observation, or becoming lost in the mass of accompanying disks. The luminous bands vary in size and brilliancy, but the disks are uniform in size and brilliancy as seen in any given experiment, The bands are bright white images, while the disks are yellow, or a part yellow and a part blue, or in some experiments they are of a luminous grayish white color. In my eye, the luminous bands show a regular pulsatory movement, synchronous with the pulse at the wrist. This I have never found absent in either eye, though probably seen plainest in the left, and it becomes more evident in proportion as the luminous bands become more brilliant. This pulsatory movement I have never observed in the disks. In the *interval* between *any two pulsatory movements*, luminous bands may *appear* and *disappear*. The currents certainly pass beyond the limits in which the luminous bands appear in the central portion of the field of vision. The luminous bands are seen with almost equal ease for an indefinite period, under the same conditions; but the power of observing the currents may be temporarily almost entirely lost.

Whether the blood globules make themselves visible entoptically as disks, by acting upon the light as small lenses, or in some other manner, it would be difficult to say with any great degree of certainty.

The demonstration of a capillary pulse would seem to be of great importance in reference to the question of the influence of the heart's action upon the circulation of the blood through the capillary system.

The ophthalmoscope has revealed the fact that under certain conditions of intraocular pressure a pulsation may be observed in the large retinal vessels. The possibility of demonstrating a retinal capillary pulsation may prove to be also of value in cases of increased intraocular pressure. There is some reason, also, for believing that the entoptic currents and luminous bands may be used as aids in the diagnosis of diseases of the retina, and possibly of those of the choroidea also.

NOTE.—My eyes, optically considered, are about normal, the intraocular pressure probably reaches the highest normal limits, and I have the power of producing a slight strabismus externus when looking in the distance, or when one eye is covered but not closed. My eyes are blue, complexion fair, and hair dark brown, with corresponding pigmentation of the choroidea.

THE EXTIRPATION OF THE FIBRO-CARTILAGE OF THE UPPER EYELIDS FOR THE CURE OF CERTAIN CASES OF ENTROPION AND TRICHIASIS.

By DR. B. A. POPE, of New Orleans.

There are certain extreme cases of atrophy of the cartilages and conjunctivæ of the upper eyelids, with inversion of their free margins, in which the operations heretofore proposed and practiced have not given entirely satisfactory results. In these cases the eyelashes are often well preserved, and even luxuriant in growth, though long in contact with the eyeballs and bathed in the conjunctival secretions. The meibomian glands are entirely destroyed, and the openings of the lids very much narrowed (palpebral phimosis). The cartilages are much lessened, in both their horizontal and their vertical diameters, and greatly thickened, and very convex on their outer surfaces.

The disease known as Trachoma is the only one capable of producing the above-described changes. And even in this disease it is only in those cases where the so-called granulations have involved the cartilages profoundly. In

addition, the disease must have been greatly neglected, which often occurs where it progresses insidiously without producing catarrhal, or purulent ophthalmia, and without affecting the cornea.

Until a year past, I have operated upon all such cases as have been just described by modifying the operation of *Arlt*, itself a modification of an operation proposed by *Jäsche*. The operation as performed by Arlt consists in the division of the lower part of the lid into an anterior and a posterior flap. The anterior flap is composed of the skin, muscle, and hair bulbs. The posterior flap comprises the cartilage and conjunctiva. The first incision is made near the lachrymal point, just outside of the line of the mouths of the meibomian follicles, and extends to the external angle of the eyelid. The incision is carried to the depth of 1½ to 2 lines. This first step having been completed, an incision is made through the skin and muscle to the surface of the cartilage, parallel to the free margin of the lid, and about a line and a half or two lines from its lower margin. The extremities of this incision extend a little beyond the corresponding extremities of the incision in the margin of the lid. The two wounds are made to communicate, so that the anterior flap is only connected with the rest of the lid by its extremities. A second incision is now made through the skin, higher up on the lid, and connecting the extremities of the first incision through the skin. The skin included by these two incisions is then removed, and the lips of the wound united by five sutures. The vertical diameter of the flap of skin removed is determined by the

conditions present in each case. In appropriate cases Arlt also divides, by a vertical incision, the lower portion of the orbicularis palpebrarum, exposed by the removal of the oval piece of skin.

In addition to the operation of Arlt, I have for six or seven years removed a portion of the muscle, so as to expose the cartilage, and then shaved off the convex and thickened portion of the cartilage down to its free margin. This greatly diminishes the rigidity of the cartilage, and favors its restoration to the normal form. The mobility of the anterior flap and the removal of a portion of the muscle renders this last step comparatively easy.

The danger of sloughing of the anterior flap seems to be very small, since no such complication has arisen in the large number of cases operated on by me in public and private practice. I have had more trouble in cases of simple excision of a flap of skin, but this is of course accidental. The results in a large number of cases are excellent, and until a year past I have adhered to this operation.

About a year since, meeting with three exceptionally bad cases, I determined to *extirpate* the *cartilage instead* of *thinning* it; *after having first taken all* the *steps* in the *operation* as *above described*.

The extirpation of the cartilage is begun by an incision in the posterior flap, along its free margin, between the cartilage and the conjunctiva. The posterior edge of the free margin of the lid having disappeared in the course of the disease, the surface of the free margin of the lid has

become changed by long contact with the eyeball and conjunctival secretions. The cartilage can probably be most easily removed piecemeal. The thickening of the conjunctiva renders the removal of the cartilage much easier. After the completion of the dissection there remains nothing but the upper rim of the cartilage, which must be beveled off from above downward and backward. The upper rim of the cartilage being left, the attachment of the L. P. Superioris is preserved. When the cartilage has been removed, the action of the L. P. Superioris upon the posterior flap is partially suspended, and after the oval opening in the skin and muscle has been closed, the posterior flap falls considerably below the anterior. This will at first seem excessive, but the process of cicatrization and appropriate after-treatment will remedy this seeming danger which is in reality, if properly managed, a great advantage. After uniting the wound in the outer flap, it is well to apply collodion between the sutures.

The wound in the lids should not be closed till all oozing has ceased. Great care should be taken that the lower edge of the outer flap should not unite too early and too high up. This can be regulated by the proper use of adhesive plaster and collodion, and by separating the edges of the wound slightly from time to time during the process of cicatrization.

This operation is very difficult, and should not be attempted except by those much practiced in the surgery of the eyelids.

It may frequently be necessary to precede or accompany the operation by that for Blepharo-phimosis.

The results in the three cases operated upon by this method were highly satisfactory. The healing process seems to be favored by the extirpation of the cartilage. After this operation there is no trouble from hair bulbs having remained attached to the posterior flap. The Entropion is much more perfectly cured than by any other operation. The eyelids are very soft, and the cases are much less liable to subsequent chronic irritation. The removal of the cartilages removes to a great extent the pressure on the eyeballs consequent on the atrophy of the lids.

It might be urged against this operation, that after its performance the eyelashes droop too much, and that the Levator Palpebræ Superioris acts insufficiently upon the inner and outer portions of the lid. These defects can, however, be much lessened by appropriate small operations on the skin which can be made after the Entropion and Trichiasis have been cured. This operative method, by diminishing the action of the L. P. Superioris, would seem to offer special advantages in those cases where the vertical diameter of the lids is very small, the eyes deep-set, and the brows very prominent. It is still more strongly applicable in those cases where the cartilages were originally very rigid, and the lids fitted tightly upon the eyeballs. The cornea seems to improve more decidedly and more rapidly than after any other operation performed under the same conditions.

The cases operated on after this method were between the

ages of ten and fifteen years old. In one case an eye had been lost and the ball had atrophied. The remaining eye was much affected, the upper two-thirds of the cornea being vascular and moderately opaque. The sight of this eye is now almost perfectly normal. A second case had been so blind as to be perfectly helpless for five years before the operation. The corneæ were opaque, softened, and conical. The tendency in this case was more to softening and opacity than to vascularity of the corneæ. The opacity was greatest at the center of the cornea. The conicity of the cornea, though not so regular as in the cases of conical cornea, was yet more so than is usual in cases of inflammatory softening. Both eyes are quite myopic. With the right eye the patient now reads No. 5 of Jaeger's test print, and is still improving. With the left eye she can only read No. 20 ; but this difference is owing to the fact that the necessary operations had not been performed on the lower lid of that eye. These operations have been recently performed, and the eye is improving with great rapidity.

The combination of the extirpation of the cartilages with the operation of Arlt, is proposed, not because it may be absolutely the best, but because it is the only one that has yet been tried by me. In the operation of Arlt, as modified by Prof. *V. Graefe*, the cartilage is better exposed for extirpation. This, of course, makes it better adapted to a regular operative method.

It is possible that the partial extirpation of the cartilages may be the best operation in that class of cases where,

though not greatly reduced in their diameters, the cartilages are much thickened, and the inversion is very decided. In these cases the upper half or two-thirds of the cartilage is but little or not at all thickened, and the change in curvature is confined to the lower part.

TEST-TYPE FOR ASTIGMATISM.

By DR. ORESTES M. PRAY, Brooklyn, New York.

Some time since, while making a small table for testing astigmatism, like those in general use, composed of lines running at different angles, the thought occurred to me that it would be better to make large letters composed of stripes, to be used in the same way as the ordinary astigmatism tables.

Any one who has examined many cases of astigmatism by means of the tests usually employed, has often experienced great difficulty in getting a patient to tell at once which of the different lines or groups of lines appeared most distinct. Great ingenuity has been shown in attempting to overcome this difficulty, but it seemed to me that the striped letters would do so more effectually than any plan yet adopted.

After experimenting for some time, I concluded to make letters three times the size of No. XL. of Snellen, composed of lines, or stripes, just equal in width to the strokes of No. XL.

By making letters half this size, with stripes half as wide,

that is, equal to the strokes of No. XX., a still more delicate test may be obtained.

Twelve letters were chosen, so as to give lines for every fifteen degrees. These letters were N, U, P, E, T, G, Z, O, B, C, D, V, in the order just given, the direction of the stripes being horizontal or 0°, 15°, 30°, 45°, 60°, 75°, 90°, 105°, 120°, 135°, 150°, 165°, respectively, numbering the degrees from left to right through the half-circle.

By putting N, U, P, E, T, G above Z, O, B, C, D, V. those letters, the stripes of which ran at right angles to each other, were placed in pairs, so that the attention of the patient could be easily directed from one letter to the othere

(N. U. P. E. T. G.)
(Z. O. B. C. D. V.)

The plate shows the first pair of letters.

To give the table a more convenient form, this double row of letters were divided thus:*

N. U. P.
Z. O. B.

E. T. V.
C. D. G.

In employing the test, the patient, with the eyes unde the influence of a sol. atrop. sulph. gr. iv. ad. ʒi, is placed twenty feet from the card, and, of course, each eye examined separately.

When there is so much amblyopia that even with glasses he letters can not be seen easily, it is necessary to bring the patient nearer to the test-table.

Generally, three or four letters will appear darker than

* The full table is to be had through the publishers of these archives.

the rest; but, upon comparing these carefully, the patient will, as a rule, decide that in one of them the black lines and white spaces are more distinct than in the others. If he can not decide between three, I take the middle letter for further experiment. Telling him to fix his attention upon the letter chosen, a trial is made with simple spherical glasses, concave and convex, to see how far, if at all, the clearness of the lines and spaces in the letter can be improved. Noting the result carefully, the patient is then directed to look at the other letter of the pair, that is, the one composed of lines running at right angles to those in the first. The same trial with glasses is made. The results obtained from the examination of the two letters are compared, and so the amount of astigmatism is discovered.

It is best to verify the final result by a trial with cylindrical glasses.

This is the old method of testing astigmatism, as far as the principle is concerned; but it seems to me that the form of test-table I offer facilitates the examination.

Two cases, one of pathological, the other of physiological astigmatism, will better illustrate the practical working of the test-type:

Miss C., æt. 26, under atrop. sulph. gr. iv. ad. ℥i.

R. $S = \frac{20}{200}$. At 15′ saw N blackest without glass. Z blackest with +18. With cyl. +18, axis vertical, $S = \frac{15}{40}$.

L. $S = \frac{20}{20}$. N blackest without glass. Z blackest with +80.

Miss G., æt. 18, under atrop. sulph. gr. iv. ad. ℥i.

R. $S = \frac{20}{40}$. N blackest with +50, Z with +36.

$$As. = \frac{1}{16} - \frac{1}{50} = \frac{1}{128\frac{4}{7}},$$ not worth correcting.

L. $S = \frac{20}{30}$. N blackest with +80, Z with +50.

$$As. = \frac{1}{50} - \frac{1}{80} = \frac{1}{133\frac{1}{3}}.$$

Note.—Shortly after the author had handed me, with a good deal of modesty, the MS. of this his first—and unfortunately last—essay, he suddenly perished by a railway accident on Long Island. He was a most talented and amiable young physician, possessing a high degree of knowledge. All who knew him felt with utmost regret, that a life had been destroyed which, preserved, would have had a share in the promotion of science for the benefit of suffering humanity.

H. Knapp, Ed.

ON A MODIFICATION OF IRIDECTOMY FORCEPS.

BY DR. R. LIEBREICH, OF PARIS.

Translated by J. H. and T. R. Pooley, M.D., of New York.

THE seizing of the iris presents difficulties in many cases of iridectomy. Although the incisions may have been properly made, and the forceps introduced in the usual manner, either they do not seize the iris at all, or only tear out a small piece of it. There are principally two classes of cases in which this happens. First, in very firm adhesions of the pupillary margin with corneal cicatrices (as after injuries and perforating ulcers), or with very firm secondary cataracts; and secondly, in adhesions of the posterior surface of the iris with the capsule, which are so frequently found after chronic iritis and iridochoroiditis simultaneously with considerable changes in the tissue of the iris. The difficulties which occur in iridectomy have been hitherto explained entirely by these structural changes in the iris, and the lesser resistance which the iris on that account presents.

A more thorough analysis of these cases, however, has

shown me that the same inconveniences may also appear when the resistance of the iris-tissue has suffered very little, or not at all, and that the true reason, common to all cases, is to be found in the extreme tension of the iris. By this the formation of folds is prevented which are an indispensable necessity for the seizure of the iris with the common iridectomy forceps.

The mechanism of the latter is different from that of common forceps, as for instance the fixation forceps. The blades of the fixation forceps are applied vertically to the surface of the membrane which they are intended to seize; the blades of the iris forceps, on the contrary, lie upon the iris and are parallel to it. Therefore the fixation forceps seize by their teeth the two points to which the open forceps are applied, and when they are closed, bring these two points together. In the iris forceps, on the contrary, it is the edges of the blades which glide along the membrane, and form a fold which is only seized by the teeth when it projects between the blades of the forceps.

Generally this folding of the iris is easily brought about, and then the iridectomy forceps are perfectly satisfactory for seizing a sufficient portion of the iris. In those cases, however, in which the iris is tightly stretched by firm adhesions of its pupillary margin or its whole posterior surface, and particularly when its tissue is notably degenerated, the blades of the iris forceps glide over its surface without forming a fold, and the teeth catch nothing at all, or only in the moment of closing the forceps seize a single point of the membrane. Instead of bringing a part of

the iris to the wound, we only pluck a little piece off the membrane.

For such cases I have now had the situation of the teeth of the forceps altered, in such a manner that the surface in which they grasp is turned to a right angle. The teeth indeed are at the front end, but not, as in the common forceps, in a surface perpendicular to the longitudinal axis, but they are concealed in the convex border of the branches, at their front end, so that when the blades lie parallel upon the iris they have the same situation as the teeth of the fixation forceps, in the perpendicular or vertical position of the latter.

The teeth in this manner come into action not only by the closing, but also by the application of the open forceps, and bringing, according as they are more or less widely opened, two more or less distant points of the iris together. The difference in the manner in which the forceps take hold in the difficult cases spoken of, is very great. Besides for the iris, they have done me good service also in the extraction of adherent secondary cataracts.

In reference to the manufacture of the instrument, it needs only to be mentioned, that the teeth, above all things, must on no account project beyond the border of the blades; the forceps must pass as smoothly through the corneal wound as the common iris forceps.

NOTE.—LIEBREICH'S forceps are to be had at
Geo. Tiemann & Co., 67 Chatham Street, and
Otto & Reynders, 64 Chatham Street, New York.

A MODIFICATION OF THE ADVANCEMENT OF THE MUSCLE.

BY DR. R. LIEBREICH, OF PARIS.

ANATOMICAL researches with regard to the capsule of Tennon, and its connection with the muscles of the eye, the conjunctiva, and the caruncle, have induced me for the last four years to modify the operation for strabismus. The following are the results of these investigations:

1. The union of the muscles with Tennon's capsule is a double one. On one side, an annular union of the posterior part of the capsule and its sheath-like processes directed toward the orbit with the belly of the muscles; on the other, a firm adherence of the anterior half of the capsule with the surfaces of the muscles which project into the hollow of the capsule.

2. The conjunctiva is firmly united with the outer surface of Tennon's capsule from the edge of the cornea as far as to an irregular, annular, well-defined boundary line, and in this way it is indirectly in very important relation to the muscles of the eye.

3. The caruncle, together with the plica semilunaris, rests on a ligament which passes from Tennon's capsule to the edge of the orbit. The contraction of the rectus internus, necessitates that by the turning in of the eye this ligament is stretched, and thereby the caruncle which is placed upon it will be drawn toward the inner margin of the orbit. But at the same time also the outer edge of the caruncle, together with the plica semilunaris and a portion of the conjunctiva lying next to and behind it, will be drawn backward and form a fold. This occurs partly because the conjunctiva in the movements of the eye lies to a certain extent close to the globe as far as a certain line, but partly also because the muscle on account of its union with the anterior half of the capsule draws the latter backward in its contractions, where the conjunctiva, plica semilunaris, and caruncle, which are united to it, are obliged to follow.

The procedure to which these anatomical observations have led me, is the following: In the tenotomy of the rectus internus, I raise up with the forceps a fold of the conjunctiva at the lower end of the insertion of the muscle, cut it through with the scissors, pass through the opening between the conjunctiva and the capsule, separate these two membranes carefully as far as the plica semilunaris, and divide the latter likewise as well as the caruncle from the subjacent parts. After having completely freed from the conjunctiva all that part of the capsule which is important for the retraction of the muscle, I separate the insertion of the muscle from the sclerotic in the usual manner, and prolong

at the same time the vertical section of the capsule above and below, the greater the retrocession is to be; and then I always close the conjunctival wound with a suture.

As the advantages of my proceeding, I have already given notice two years since, first in the "Archiv. fuer Ophthalmologie," of the following:—

1. A greater freedom, and a much greater interval for the graduation and the distribution of the operation for strabismus.

2. The avoiding of the sinking in of the caruncle, and every trace of a scar, which are sometimes left behind in the ordinary tenotomy.

3. The avoidance of more than two operations in the same individual, and also of more than one on the same eye.

It has never entered my mind, as has been erroneously affirmed, to recommend the correction of a high degree of strabismus by a single operation.

After having described this modification of causing retrocession of the muscle more than two years since, I now first communicate an analogous modification of its advancement, for the simple reason that, though I had very soon numerous opportunities to try the proceeding for common tenotomy, the indication for advancement occurs much seldomer. But now I have further been able sufficiently to observe the results of the latter, to feel justified in recommending the following proceeding.

After a broad vertical incision of the conjunctiva in the neighborhood of the insertion of the muscles, or better somewhat behind it, I burrow beneath the conjunctiva with the

scissors, both toward the cornea and the opposite directions so as to separate it completely from the subjacent Tennon's capsule. Afterward I make the tenotomy and cut the capsule above and below, in the direction of the insertion of the muscle, so far that the muscle and the part of the capsule that lies upon it are completely movable, and may easily be brought forward to the border of the cornea. Here I fasten them in the following manner. I pass two fine needles, attached to the two ends of the same thread, above and below, at a distance of about one line from each other; first through the capsule and the end of the muscle, and then from behind forward through the conjunctiva, and tie the loop over the conjunctiva. Of such sutures, or rather loops, I apply at least two, one in the neighborhood of the upper, and the second in the neighborhood of the lower border of the muscle. After the muscle and the capsule are in this manner fixed beneath the conjunctiva close to the edge of the cornea, I carefully unite the conjunctival wound with several sutures. If the attainment of the mechanical design demands the shortening of the muscle, this presents no difficulties; on the contrary, this proceeding favors, when necessary, the removal of a portion of the anterior extremity of the muscle and also of Tennon's capsule.

By the latter procedure, we are able to produce a considerable effect on the prominence and apparent size of the eyeball.

But the advantage of this proceeding lies in this, that we avoid thereby the cutting out of the conjunctiva, which very often leads to essential inconveniences, in particular long re-

maining irritation, tight folds impeding the movements of the eye, &c. In every case it is more rational to spare the conjunctiva, if its excision is not requisite to attain the mechanical effect.

TWO CASES OF EXTRACTION OF A FOREIGN BODY FROM THE CORPUS VITREUM.

By DR. R. BERLIN, in Stuttgart.

The interest Prof. *Knapp* kindly expressed, at the last Ophthalmological Congress at Heidelberg, in my observations about foreign bodies in the corpus vitreum, encourages me to relate the history of two new cases, in which a foreign body has been extracted from the corpus vitreum. The first case shows how important it sometimes may be, for the diagnosis, to know exactly the power by which the foreign body was moved forward. The second case confirms the value of a "limitation of the visual field," found shortly after the wounding of the eye, both for the diagnosis of the presence of the foreign body in general, as well as for the discovery of its position. Besides that, it shows a progress in the method of extraction.

1. A young woman serving in a shooting-gallery for air-guns, had been wounded by the awkwardness of a man, who struck her right eyebrow with the barrel of the charged gun. At the same

moment the gun went off. The girl staggered, but did not fall. Half an hour later vomiting occurred which was repeated twelve times during the same night, alternating with diarrhœa, short attacks of fainting, and giddiness. About 12 hours after the accident I saw the patient for the first time. I found her a strong young woman. She then showed no derangement in her general health, especially no fever and no retardation of the pulse. The eyelids on the right side, and the surrounding parts, were extremely swollen and suggillated. It was very difficult and painful to draw the eyelids apart. When open they showed the conjunctiva greatly swollen around the opaque and somewhat gray cornea. The latter itself was lacerated by a wound having four rays, which met about the center of this membrane. The peripherical ends of the rays reached almost to the border of the sclerotic. The eyeball was collapsed and soft. The sensation of light wholly lost. The grave nervous phenomena which existed, such as fainting, giddiness, and chiefly vomiting, so often repeated, might be reflective symptoms due to the violent concussion of the eyeball, or they might be, in spite of their cessation for the moment, the direct effect of a real wound of the brain. It was therefore now the main question to judge, whether the power of the air-gun was great enough to drive the ball forward into the brain. For this purpose I sent to the owner of the gun, in order to obtain a statement of the charge usually employed. But as he could not give me the information I desired, I tried the same gun myself. We shot against a deal door at a distance of 4 paces. The usual lead ball, which had a diameter of somewhat more than three lines, was thrown back by the soft wood, and only left a superficial mark. By this trial I was convinced that the ball had not force enough to pass twice through the membranes of the eyeball and also to penetrate through the contents of the orbit and its bones. As it was impossible to restore the sight, I now dared to examine the interior of the eye with a button-probe. After some

attempts I found on the bottom of the eyeball a hard object with a smooth surface. It was very easy to catch it with forceps, and, after having enlarged one ray of the wound, to extract a little lead ball of about 3 lines diameter.

After the removal of the ball none of the grave symptoms were repeated. The inflammation of the eye and the swelling of the lids diminished gradually. Eighteen days after the operation the patient was dismissed, of course with a shrunken eyeball, but free from trouble.

2. A smith, employed in a machine manufactory, felt his right eye hurt, whilst he was chiseling cast steel. Immediately after he was wounded, he remarked an obscuration of sight, which increased very quickly. Four hours later I saw the patient. The conjunctiva of the eyeball was moderately inflamed, the cornea had a perpendicular sharp wound more than 3 lines long, which was situated in the upper part and on the outer side of the vertical meridian. The wound reached to the sclerotic. The anterior chamber had disappeared; the eyeball was very soft. The iris and the lens were cut in the same direction as the cornea. The lens was already opaque. When I examined the acuteness of sight in a dark room, I found that a candle, giving a moderate light, was recognized at a distance of about 6 paces. When the candle was quickly moved before the eye, its position was only noticed in the lower half of the field of vision. By this limitation of the eccentric sight it was proved, that the interior parts of the retina did not perceive the light, or that, because of some material obstacle, the rays could not reach the retina. Guided by a large series of anatomical investigations made on eyeballs which were extirpated soon after the entrance of foreign bodies into the corpus vitreum,* I concluded that the limitation of the field of the vision was the effect of

* These observations I published in *Von Graefe's* Archiv. fuer Ophthalmologie, XIII. 1, and XIV. 2.

an extensive hemorrhage in the lower parts of the corpus vitreum.

The origin of these hemorrhages are wounds of the choroid and retina on the posterior wall of the eye, produced under similar circumstances, not by concussion of the eyeball, but by the direct blow from the foreign body. These wounds of the interior membranes always happen, if a foreign body enters wholly within the space of the corpus vitreum. For the force which drives foreign bodies forward through the resistant external walls of the eye is too great to be broken by the resistance of the soft corpus vitreum. The most important symptom, however, for the diagnosis of the entrance of a foreign body into the vitreous, and its sojourn within it, is a limitation in the upper part of the field of vision, found immediately after the injury of an eye. This holds good especially in cases where the wound is small and penetrating, and where the circumstances, under which it happened, make it probable that the wounding body was also small. As to the position of the foreign bodies, heavy ones, which are not fixed in the posterior wall of the eye, are always found on *the bottom of the eyeball.* This position they reach by being repelled from the posterior wall and sinking afterward by their own weight. All those heavy bodies, whose position on the bottom of the eye I had the opportunity of measuring in the anatomical examination of extirpated eyes, were found a *little before the lower part of the equator* of the eyeball. If an abundant hemorrhage was detected, the greatest quantity of blood was found about the foreign body. In the

cases known to me, examined immediately after the accident, in which the body was found fixed in the posterior wall of the eye, an extensive hemorrhage was never observed, and I believe that in such cases there will be little or no limitation of the field of vision. On the other hand this limitation has hitherto always proved to me that the foreign body should be found on the bottom of the eyeball. Guided by this anatomical fact, I found in two recent cases the foreign bodies, whose presence and position I diagnosticated from the limitation of the visual field, by an incision into the sclerotic of the living eye, made between the edge of the cornea and the lower part of the equator. In one of these cases the foreign body could be extracted, but the eyeball shrunk afterwards. It is sufficiently known that the larger wounds of *the sclerotic* are very dangerous, because they very often cause subsequent detachment of the retina by the shrinking of the cicatrix. Therefore it is necessary to choose another part of the eye for the incision and extraction of the foreign body, lest the sight be endangered by the operation itself. Of course the part most capable of supporting a surgical operation, is the junction of the cornea with the sclerotic.

The patient entered my hospital next day, the 13th Aug., 1868, about 24 hours after the accident. The inflammation had increased and the conjunctiva began to grow œdematous; the neighborhood of the corpus ciliare was very sensitive; the acuteness of sight had greatly diminished. By these symptoms it seemed probable to me that a purulent inflammation of the interior membranes was beginning, and that there was no hope of a recovery of sight by

the removal of the foreign body. Without the extraction of the foreign body, the right eye was not only certainly lost, but there was, besides, the danger of sympathetic inflammation of the left eye. Therefore, unless we should have preferred to do nothing, there was only the choice between the extirpation of the eyeball and the trial of extraction of the foreign body. I believed it to be right to let the patient himself decide what should be done, after having carefully informed him of the probable consequences. He preferred the trial of extraction, although I had pointed out that the discovery of the foreign body was by no means certain. The operation was performed in the following manner: First, I made with the small cataract knife of *Von Graefe*, on the lower edge of the cornea, the ordinary cut for extraction of cataract.* This cut was performed a little longer than is usual. Then, after having excised the iris and drawn out the cataract, I entered with the knife into this wound and opened the posterior capsule of the lens and the hyaloid, as far as possible, in the same direction. Having now got a way to the interior of the eyeball, I sought with a probe for the foreign body on the bottom of the eyeball before the lower part of the equator. After several fruitless trials I found a hard resistance at a distance of about 4 lines from the inner edge of the wound made in the corneal margin for the extraction of the lens. After that I was able to seize the object with forceps, and I drew out a small piece of iron 3½ lines long, and about 2 lines broad, which the patient recognized as broken from the edge of his chisel. The next day the chemosis had somewhat increased, and diffuse opacity of the cornea set in. The eye shrunk gradually and without trouble by suppuration of the vitreous. The patient could be dismissed with a moderate eyeball the 6th Sept., *i. e.*, 24 days after the operation.

* *V. Graefe*, too, has of late recommended this section as the most appropriate for the extraction of foreign bodies from the vitreous. Confer. Arch. f. Ophth., XIV., 3, p. 146.

As previously mentioned, I was prepared for this result, which became already more evident, when together with the extraction of the foreign body a little blood and yellow matter came out, which, with the aid of the microscope, I recognized as pus.

In consideration of the unfavorable prognosis of this case in general, and the wish of the patient to have the extraction of the foreign body tried, I thought justified in doing this; imagining at the same time the case would furnish a direct proof of the diagnostic value of the limitation of the visual field, moreover afford a good opportunity to try a new method of extraction, which, of itself, does not absolutely endanger the existence of the eye. The satisfactory result thus obtained has decided me to employ the same method in similar cases which may present themselves to me hereafter.

DISLOCATION OF THE CRYSTALLINE INTO THE CORPUS VITREUM, AND AFTERWARD INTO THE ANTERIOR CHAMBER.—THE EFFECT OF REFRACTION.

BY HENRY D. NOYES, M. D., OF NEW YORK.

THE following case came under my observation at the New York Eye and Ear Infirmary, being brought to my notice by Dr. *Watts*, who had charge of the patient, and who requested me to make such use of it as seemed proper. Accordingly, an account of the interesting facts as regards the refraction of the eye appeared in the *Medical Record* for March 1, 1869, but at that time the clinical history was incomplete. I am able now to give the case in full, and hope that a partial repetition will be justified by the rarity of the observation.

A man, 45 years old, in a drunken brawl, received a blow with the fist on the left eye. About three weeks after it happened, that is, in December, 1868, he came to the Infirmary. He was examined by Dr. Watts who found the crystalline lens to have been dis-

placed directly downward in a vertical plane, and its upper border projected above the rim of the enlarged pupil. A solution of atropia had been put into the eye to facilitate the ophthalmoscopic examination. No other injury was discovered, and the eye was but moderately injected. Sight appeared to be as good as the altered conditions of refraction would admit, but no examination with trial-glasses was made.

About a week after he said that his sight had greatly improved. He was now able to read, which before was not the case. The crystalline was discovered to have come forward into the anterior chamber. This fact was easily known by the way in which the iris was pressed back, and by the brilliant border of the lens where intense reflection of light occurs. The lens had a faint amber tinge appropriate to the age of the person, but was perfectly transparent. It was of course still inclosed in its capsule.

The change of position had been brought about by a vigorous fit of sneezing. On the evening of the last day when he visited the Infirmary, and when atropia had been put into the eye, he took a pinch of "catarrh snuff," and sneezed seven or eight times. Immediately afterward he found his sight improved.

In this novel state of affairs I at once proceeded to ascertain what was the exact effect on the refraction. As the nodal point was very decidedly advanced, the eye, if formerly emmetropic, must now have become myopic.

The interesting point was the degree of myopia. Inasmuch, too, as the lens is in bulk not equal to the capacity of the anterior chamber, and its specific gravity heavier than that of the aqueous humor, its axis does not coincide with the visual axis but lies below it. Hence there must be astigmatism.

The examination was made both by myself and by Dr. Schiff. The good eye was found to have hypermetropia manifesta, 1-18.

The injured eye to have myopia 1-9 and myopi astigmatism 1-24.

The formula for the two eyes are

O. D. Hm. 1-18 V. = 20-40.

O. S. M. 1-9 A^s M 1-24 axis 30° (paral.) V. = 20-50.

If we assume that originally both eyes had the same refraction, namely, hyperopia 1-18, which is probably less than would be exhibited with atropia, we find the displacement of the lens with the anterior chamber to be optically equivalent to myopia 1-6.

The results found by trial-glasses were afterward verified by the ophthalmoscope with the upright image, and proved to be in accord.

I am not aware that any similar observation is recorded, and think the fact worthy of note as a contribution to physiological optics.

There was at this time no irritation of the eye. The removal of the lens was hinted at, but the man was unwilling to submit to any operation. It was hoped that trouble might not arise, but the man was warned to return immediately in case of any mischief.

After about a month's absence he returned with the account that after a little while the eye had begun to inflame, that he had suffered intensely, been deprived of sleep, but was dissuaded by his friends from coming sooner to the Infirmary. Now the lens was opaque and the eyeball in a state of complete glaucoma. There was no perception of light—the globe hard and painful on pressure; there was considerable ciliary hyperæmia.

For the sake of rendering the eye quiet it was decided to remove the lens. This was done under chloroform, by means of Graefe's knife. Vitreous escaped during the operation. The reaction which followed was pretty severe, and suppurative iritis ensued. After being in the Infirmary about three weeks he was dismissed.

I saw him on March 20th; the eye now comfortable, scarcely any visible hyperæmia, the cornea hazy, an exudative tissue occupies the pupil and runs across the front of the iris—the globe has normal tension, it bears pressure without exhibiting pain—there is not the least perception of light.

STRICTURE OF THE NASAL DUCT

By E. WILLIAMS, M. D., of Cincinnati.

The literature of lachrymal obstructions forms a long and knotty chapter, in which every new method of treatment proposed, while promising the happy solution, has proved inadequate, and shared the fate of its predecessors.

I was very forcibly struck with this idea when reading the discussion in the Ophthalmological Congress at Paris in 1867, elicited by Mr. *Laurence's* paper on extirpation of the lachrymal gland. The twenty cases of extirpation which he then reported had all been unsuccessfully treated for epiphora by other methods, but mainly by *Bowman's*. He states that the weeping ceases, but the moisture of the eyes remains normal. This extreme and radical measure was severely criticised, but from very different motives, by different members. *Wecker* had happily never been *reduced to the necessity*. Prof. *Arlt* opposed it as unjustifiable in the treatment of diseases of the tear-sac, and not free from danger to life. Besides, he was well satisfied with

Bowman's method, and only in very rare cases failed to obtain his object by this treatment. He had only had recourse three or four times to obliteration of the tear-sac with the hot iron. The Spanish oculists came out in solid phalanx in favor of obliteration, as affording brilliant results, at least in their country, exhorting the doubting Thomases to "come and see." Finally, *Giraud-Teulon* and *Warlomont*, with true French courtesy, insist that it is here a question, not of principles, but much more of two large classes of facts, dependent on differences of climate, or other similar causes. It is undisputed that by the conservative method—that is, by progressive dilatation of the tear passages—a large number of cases are cured; that, however, in other latitudes occlusion also affords capital results.

A warmer climate, especially, might explain the different results as to the remaining epiphora, which is the chief objection urged against obliteration. It is well known that, with most patients, the weeping is much more annoying in winter than in summer.

Judging from the discordant views just alluded to, we infer that the combined wisdom of Europe, represented in the congress, is not yet sufficient to settle the question of the best method of treating strictures of the lachrymal passages. The serious proposition to generalize extirpation of the tear-secreting organ, as a means of combating epiphora, leaving the fons et origo, the suppurative inflammation of the sac, and the stricture to take care of themselves, is, to me at least, rather amusing, when there are so many "ra-

tional and very certain ways of removing the obstruction." It is like chopping the patient's head off to relieve him of the pains of an inverted toe-nail, or costive bowels! The old method of occlusion of the sac is far more rational and free from objection than extirpation of the gland. The former, indeed, is only indicated in bony atresia of the nasal duct with troublesome lachrymal tumor, or in extensive caries of the bones, both of which are extremely rare. Extirpation of the gland is unjustifiable, except as a means of palliating the stillicidium lacrymarum which accompanies incurable ectropium or loss of the eyelids or of the canaliculi. As obliteration of the sac has been recommended on the one hand, and extirpation of the gland on the other, why should we not combine the two and make a sure and a clear thing of the whole difficulty?

My object, however, in writing this paper is not the easy task of finding fault, but to give a succinct statement of my own experience in the premises. As a zealous disciple of the elder *Desmarres*, I practiced occlusion in all bad cases of lachrymal tumors, with or without fistula, for several years. Milder ones were subjected to palliative treatment only. A new era was at length inaugurated by *Bowman*, who happily suggested the natural and easy way of opening the sac through the canaliculi. I then adopted his method, and found that in the immense majority of cases of stricture of the nasal duct, it afforded great relief, and in many a permanent cure. Relapses, however, were frequent, and in some the treatment failed altogether; so that I still had to fall back, now and then, upon occlusion.

Weber's idea of slitting up the upper canaliculus instead of the lower, and of using larger probes and more systematic medication of the diseased mucous membrane by astringent injections, seemed to me an improvement. In repeated trials of his operation, I became convinced that unnecessary injury was thereby done to the tear-sac and mucous membrane; and I found also that relapses were occasionally observed even after long continuance of the treatment.

After a thorough trial of both these methods, I began to consider what might still be done to insure greater success. To adopt a treatment which should combine more certain relief with less suffering and loss of time to the patient, as well as less trouble to the operator, was my object. For more than seven years I have pursued a method that has afforded a much larger percentage of permanent results, with vastly less suffering to the patient and trouble to myself. In the *Cincinnati Lancet and Observer* of November, 1864, I published my first account of the procedure, and five years more have only confirmed my then very favorable experience. *The essential and peculiar feature of the treatment consists in causing the patient to wear the stile constantly during the whole course of treatment, instead of its occasional temporary introduction.* True, Bowman had suggested the wearing of a small wire for a few days at a time, but this I found insufficient.

Warlomont, in the *Supplement to Mackenzie*, describes a case of a young girl whom he made wear a small silver stile for a month after cauterization of the sac with chloride

of antimony. But it was not recommended as a uniform practice. So general was the aversion to the old method of wearing a stile (of whatever material) through the fistulous opening in the skin, that the idea of returning to the same treatment in a modified form was not well received. The failure, as I conceived, and as my experience has demonstrated, did not attach to the use of the stile as a means of dilatation, but to the *artificial opening*, whether through the skin or the conjunctiva, in which it was worn.

The stricture of the ductus ad nasum was no doubt cured in most or all of the cases, but in accomplishing this a worse condition was brought about by the injury done to the sac, and the parts overlying its junction with the nasal duct, by the presence of the stile.

Its contact with the raw edges of the fistula caused inflammation, ulceration, thickening, and subsequent rigid contraction, with, frequently, complete closure of the sac at the commencement of the nasal duct. Thus there was produced a mechanical difficulty in the absorption of the tears, as well as a new obstruction to their passage from the sac downward. It is perfectly clear that the wearing a stile through such an opening, was altogether different from the method which I have introduced. The presence of a smooth silver stile, even of large size, in a natural opening, lined by *mucous membrane*, is tolerated with impunity, and the results are altogether different. The reintroduction of the continuous use of the stile, under more favorable auspices, in the treatment of stricture, is all that I claim.

I had a series of silver stiles made and numbered from 5 to 9, inclusive, of the bougie scale, my *smallest* corresponding to Bowman's largest, and being about one-sixteenth of an inch in thickness, the largest being one-eighth of an inch. They are from one and three-quarters to two inches long, to suit different cases, slightly conical at one end and flattened at the other. I order them straight, and bend them in each case to suit the length of the nasal duct and the peculiar conformation of the inner canthus. I have tried stiles of pure tin, of lead, and of hard rubber, but prefer the soft virgin silver.

I have modified my procedure in several particulars since my first published paper. As before, I slit up the superior canaliculus, but no longer with Weber's knife. A delicate pair of scissors, with one branch probe-pointed and slightly longer than the other, answers the purpose admirably, and is much quicker done and less painful than the knife, for obvious reasons. I do not now cut the sac, but simply slit up the canaliculus down to it, or nearly so. If I there find its inner orifice dilatable I expand it with a conical probe till it will admit Bowman's No. 6. Should the canaliculus be closed near the sac, I guide the point of a cataract knife along the probe and puncture the sac. This done, I at once proceed to explore the sac and duct. For this purpose I use generally a set of probes like Bowman's, except that they terminate by bulbous ends and are much smaller for about half an inch above, so as to yield more easily. These were invented by my friend Dr. *Henry Williams*, of Boston, but I find that *Teale*, of Lon-

don, used exactly the same kind of probes in 1860. (Med. Times and Gaz.) The bulb on the end of the largest, marked 6, is the size of my stile No. 5. They are very *insinuating*, and useful in exploring the tear-passages. After passing one of them, I learn the peculiarities of the canal to be traversed, and can then put Bowman's No. 6 through with greater certainty and assurance. If the stricture is not very tight, I soon coax one of these flexible probes through into the nose, using but very moderate force. In case the resistance is too great to be overcome by these probes or small bougies, or flexible rubber probes, I lay them all aside and force the stricture either with No. 6, or with Weber's bicone, or what is still safer and better, a probe of the following description. It is of silver and double, like Bowman's probes. At each end is a conical enlargement of different sizes, which reaches its greatest thickness at from 3½ to 4 lines from the end, and then diminishes rapidly again to about one-fourth of the size of the expansion. The smallest expansion is about one line in thickness, and the largest one and a half lines. If force must be used to pass the stricture, the larger the probe the less danger there is of making a false passage. The probe just described (I do not remember whose idea it is) is admirably adapted for this purpose. The thick part fills the duct and keeps the conical point in the axis of the canal. With reasonable care to keep the instrument in the direction of the canal, there is no possible risk of piercing the mucous membrane. Besides, it enables us to determine the exact seat and number of the strictures,

which is impossible with a probe of uniform size or gradually increasing all the way, as in Weber's bicone.

Having now entered the nose, I leave the probe a few minutes, and then withdraw it in favor of a stile that I introduce to remain. Before removing it, however, I mark the point that corresponds to the place of junction of the sac and canaliculus, so as to measure off the required length on the stile No. 5, which is now to be bent to fit, and passed in to remain. With a pair of pliers I bend the flattened end so as to make it hook down over the lower lid. A second bend outward, just below the first, makes it fit much better and prevents the lid from dragging the hook round against the eye. This is next passed down and left in, if it fits at all well; if not, it is again withdrawn and bent to better suit the peculiar shape of the canthus. Instead of flattening the upper end, I now generally leave it round and slightly smaller for about half an inch from the end. In most cases the pain, caused by the presence of the stile, passes off or abates very much in a few hours, so as to become endurable. It is a rare thing now to find a patient that will not bear the stile from the very first. Should the pain be excessive and the swelling increase for several hours, in spite of morphine internally and cold water locally, I take it out and try it again the next day or the day after. I always fit the patient with the permanent stile at the first operation, and rarely find that it is not borne as well as later. In 48 hours I usually find the stile so loose that it can easily be withdrawn and the sac washed out with tepid water. If the water passes in a free stream through the

nose, the passage is free, and the stile all right. Should the water not pass at all, or only imperfectly, there is a stricture at the nasal end of the duct and the stile is not long enough. The bulbous probe is now passed down the canal explored anew, and a longer stile adopted. I gen erally pass the stile down till its nasal end rests against the floor of the meatus or almost touching it. Strictures at the nasal outlet of the duct require more care and longer stiles than those higher up in the canal. For washing out the sac, I find the hard rubber dental syringe the best. I have them made with straight, short, conical nozzle to receive a silver point, bent at right angles to be slipped over it and made tight. Of these points I have 3 sizes, the largest of the size of No. 5. In very timid and sensitive patients, I sometimes leave the stile several days, or even a week before taking it out the first time. Indeed, I frequently send the patient home, if he does not reside in the city, and leave it in several weeks, after I am sure it is right, and going to be well tolerated. Where there is much discharge I remove the stile and wash out the sac once a day. When there is little or no secretion, every two or three days will suffice. As soon as No. 5 is quite loose and easy, I put in No. 6, bending it in the same form. When this size is attained, I commence the astringent injections each time, or every second or third day according to the amount of blennorrhœa, passing a few drops through after the water, and then at once reintroducing the stile. The solution I generally employ is 20 grains sulph. cupri to an ounce of water. If the parts are very sensitive and inflamed, I adopt a much weaker solution (2 or 3 grains) in

the commencement, and gradually increase the strength. Nitrate of silver may in some cases be better borne, varying in strength from 10 to 20 grains, according to the indication. These injections, with astringents, form a very important part of the treatment where there is blennorrhœa, with or without dilatation of the sac; and it is often very gratifying to see how rapidly the discharge is controlled by them, and the sac made to contract to its normal size. As the state of the mucous membrane improves, the astringents are to be gradually diminished in frequency and in strength. In three or four weeks usually, No. 7 may be reached, and finally, No. 8, which is to be worn for several weeks or months longer, till all suppuration has ceased, and the sac contracted to its natural capacity. There is much more danger of not wearing the stile long enough than too long. The whole duration of the treatment lasts generally about three months, but it varies very much in different cases. I now rarely use the No. 9. It is very large, heavy, and somewhat disagreeable, as well as difficult to bend suitably. The No. 8, is large enough, especially if it is worn *long enough.*

After the first few days, the stile causes no special inconvenience, and the patient can pursue his usual avocation. By selecting a stile of the right length, and bending it nicely, it can be so closely adapted to the corner of the eye as to attract but little attention. Instead of refusing to wear stiles the patients are often reluctant to leave them off, finding so much comfort from their use. In a few cases the contact of the stile produces little fungous growths at the

opening in the sac, which can be readily snipped off. Rarely, when the outward bend, below the hook, is not sufficient, the sides of the slit-up canaliculus grow together external to the stile; but this has no special disadvantage. The stile should always fit comfortably so as not to drag on the lids, and be perfectly smooth.

The advantages of this method over Bowman's, and all others, in my experience, are many. In the first place, it effects a larger percentage of complete cures. All are greatly and permanently benefited, and the immense majority completely relieved. Of the hundreds of cases which I have thus treated in the past seven years, I do not remember more than five or six that have not been entirely relieved; and even their condition is far better than before the treatment, troublesome epiphora being now the only inconvenience, no serious inflammation, no abscesses, and but little mucous secretion. Many patients complain simply of watery eyes while they retain the stiles; but the epiphora nearly always ceases in a few weeks, or at most months, after leaving them off. Of all the cases treated, I have found it impossible to get through the nasal duct in but two, and one of them was a case of long obstruction following fracture of the ossa nasi. I believe with Prof. *Arlt*, that complete obliteration of the nasal duct is extremely rare. Another superiority of this treatment is that it is far less painful to the patient to wear the stile than to have it introduced occasionally, for half an hour, as practiced by others. Each introduction is painful; the patient thus becomes *demoralized*, and is apt to cease attendance too soon, especially as he

must lose half an hour each time in waiting to have it taken out. When the stile is worn, all the hurting is at the start, *when people expect to be hurt*, and will bear it. Another important consideration is, that, in a couple or three weeks, the patient can easily take out and put in his own stile, and use the injections, thus saving much time and expense. After reaching No. 6, I often let them go home for a few weeks, supplying them, of course, with a syringe, medicine, and the proper directions. When convenient, they *come back*, have a larger No. put in and again return home. So little trouble do I have after the first few days, that even children of four or five years allow the stiles to be changed and the injections practiced at pleasure.

In view of the fact that I treat all my cases by this method, in many of them both sacs having to be treated simultaneously, and that I have had the usual number of the worst complications in the worst class of subjects, I know that my results are far better than any I have seen or read of in the experience of others. That dilatation, as practiced both by Bowman & Weber, does not afford results uniformly satisfactory, is quite evident from the recorded statements of many writers, and the recent serious proposition of extirpating the gland, or of obliterating the sac, as in times of yore, as a common treatment for epiphora from stricture of the ductus ad nasum. Certainly the occasional passage of even a small probe through a stricture, and the use of injections often affords permanent relief, and nearly always temporary amelioration. Still the success is not nearly so prompt and permanent as may be obtained by the modifi-

cations which I have described. Although once addicted to it, I have not obliterated a tear-sac for the past seven years, nor found it necessary to remove the lachrymal gland in but one case where both canaliculi were incurably closed. In that instance the success in relieving the epiphora was perfect. The extirpation was performed by my nephew Dr. A. D. Williams, who has recently published the history of the case. A few minutes after the operation, I put a drop of vinum opii in each eye. While the one quickly filled and overflowed with tears, the other remained comparatively dry, and only ran a drop or two after some minutes. While I admit that extirpation of the gland greatly ameliorates the condition of a patient with obstructed tear ducts; it is certainly unnecessarily severe when there is a rational and very sure way of removing the obstruction. I do not claim invariable success for my method, but only a much larger proportion of perfect and permanent cures than can be attained by any other known to me. The large probes, the bougies, the laminaria digitata, &c., are useful in certain cases, but not so generally successful because they are used on the principle of *occasional periodical dilatation*, instead of being *constantly worn* till the cure is accomplished.

The appearance within the past year of *Stilling's* monograph on division of the stricture, and more recently of an article in the *Annales d'Oculistique*, by *Warlomont*, detailing twenty successful cases by the same method; as well as the earlier experience of *E. Jaesche* of Moscow, in very much the *same treatment*, leads us to hope for still further

improvement in the methods of treating this proverbially troublesome disease. *Stilling's* method consists essentially in slitting up the canaliculus, passing a small grooved director down to or through the stricture, if possible, and then passing a suitable knife down through and incising it freely in three or four different directions, so as to make the canal perfectly free. No probes or stiles are to be used afterward, indeed little if any further treatment. In the cases reported by Warlomont, no other treatment was instituted. If the immediate improvement effected by this operation proves to be permanent, it is certainly a great abridgment and simplification of the therapeutics of stricture and its complications. While I sincerely hope it may prove as valuable as its sanguine advocates allege, I must suspend judgment till it is tested by a larger and longer experience. We have recently tried it in four patients. In these we operated according to Warlomont, first passing the bicone of Weber to make way for the knife, and then making free incisions in several different directions.

In one I used a knife of the dimensions of Stilling's, but with a narrower and slightly blunt point. I passed it through the upper punctum down into the sac, and directly on through the stricture, incising the canaliculus and stricture by one continuous operation. A large sound was then introduced, and the whole canal found perfectly free. In this patient the sac was dilated to the size of a large filbert and filled with muco-pus. There was rapid and great improvement, and already in six weeks' time the patient considers himself cured. No treatment but the operation was used. The sac is still very slightly dilated, but has ceased to suppurate, and the epiphora is gradually diminishing. Of course, the final result can

not yet be determined, but the case is very promising. Of the other three one is a scrofulous woman with caries of the bone at the lower end of the duct, that I had treated for months with my stiles and injections. Twice, relapses of suppuration and pain took place after suspending the use of the stiles. I then resolved to try incisions. In the first operation the knife was not long enough to reach the lower and worst stricture at the outlet in the nose. The mattering ceased, however, and the patient improved for a week. Then the suppuration and swelling returned, and I made a more thorough division of both strictures, passing the knife freely into the nose, as well as a large probe. Immediate and great relief followed, so that in two weeks from the second operation the patient went home thinking herself cured. To-day, however, just one month after the operation, I received a letter from her, stating that the suppuration has returned and she is suffering pain in the nose.

Another was in a young man of strumous diathesis, and the victim of chronic trachoma, ectropium of the lower lid, and free suppuration in the sac. The incision was made very thorough, and the canal is still free, as proved by the occasional exploration since, with an elastic bougie. It is now five weeks since the operation, and matter can still be pressed from the sac each day, as he comes for the local treatment of the trachoma. I fear he also has caries of the bony canal. It is but just to say that these two were both very unpromising for any treatment. In the only two fair cases, the result is so far extraordinary, while the other, an incysted lachrymal tumor, was operated only to-day.

In concluding my paper, I wish to give a summary of two rare affections, in connection with the lachrymal apparatus, that have recently come under my observation. The *first was periodical epiphora, due to paresis of the fibers of the obicularis which cover the lower tarsus.*

The patient was a young lawyer, in perfect health, and free from all inflammation about the eye or the lids. During the warm weather of last summer he began to be annoyed by a weeping of his left eye, which came on once in three or four days, lasting for a few hours, and then passing off entirely. When he consulted me it had already lasted for several months. In walking or riding, it would often come on him suddenly, and cause him great inconvenience for perhaps half a day, and then disappear as suddenly as it came. On examination, I found no obstacle whatever in the tear-passages, nor indeed any thing else to account for the strange phenomenon. Finally, I suspected paresis of the orbicularis, and on careful examination I found that by drawing down the lower lid and holding it for a few seconds, it did not so quickly adapt itself to the eye again as on the other side. Judging this to be the only possible cause, I applied a mild galvanic current for half a minute to the lower lid. The epiphora at once ceased for 24 hours, when it recurred, and was again instantly stopped by the same application. After the third application the intervals between the paroxysms of weeping became longer and longer. I directed him to come and have the current used whenever the epiphora returned, which he did, till, in the course of some six weeks, it ceased entirely, and has not troubled him since.

The facts in the case are interesting, as showing the action of the *inferior palpebral portion* of the orbicularis on the absorption of the tears, and the prompt and permanent cure effected by electricity. Why the paresis should have affected that one limited portion of one muscle alone, I do not comprehend. This fact, like many others, can be made to confirm each one of three or four different and even antagonistic theories, of the absorption and conduc-

tion of the tears. So I turn it over, with my compliments to *Henke*, *Arlt*, *Stellwag*, and *A. Weber!*

Another case, which I consider almost or quite unique, is that of a *dacryolith in one of the excretory ducts of the lachrymal gland.*

The history is briefly this: a delicate girl 6½ years old, began suddenly to complain of an uneasy rubbing feeling under her upper eyelid. No cause for it could be discovered for some time, but the mother at last on raising the upper lid and causing the child to look down to the floor, saw a little lump on the upper and outer part of the eyeball. The patient was brought to us on the 23d of February just past. On inspection I saw a whitish prominent body, about the size of a small grain of wheat, under the conjunctiva scleroticae at the upper and outer part near the cul de sac. To the touch it was very hard and freely movable under the conjunctiva. Just external to it, and at the bottom of the cul de sac, was a slightly hypertrophied portion of the palpebral division of the lachrymal gland. Directing the little patient, who was very sensible, to turn the eye far downward and inward, I pinched up the conjunctiva over the little tumor, snipped it with the scissors, and then seizing the mass with the forceps, easily removed it with the scissors. It was hard as marble, white, almost transparent, and in the shape of a hemisphere, the flat side resting against the sclerotic. It was closely invested by a thin but firm membrane, which I took to be a portion of duct much dilated. That it is a concretion in an excretory duct deposited from the tears, I think, can not be doubted. By measurement the concretion is 5 millimeters long, 3 wide, and 2 in thickness, weighing one-third of a grain.

The only cases of supposed concretions in the excretory ducts of the lachrymal gland, which I can find reported by

authors, are three in number. Two of these were in *young girls*, where large numbers of hard, chalk-like particles were removed from the cul de sac of the conjunctiva. It is by no means certain that they were not put in the eyes by the patients, to excite sympathy and surprise. I once saw a young lady with caries of the orbita, who repeatedly introduced pieces of wood and fat meat into the eye, which were afterward removed from beneath the lower lid, where they excited most violent inflammation. I extracted a piece of match, and a morsel of fat pork from the eye myself. Up to that time the friends were dreadfully exercised as to whence these foreign bodies came! In the other case of a soldier reported by Laugier in Mackenzie's work, it may have been a concretion in a meibomean follicle. Be this as it may, the novelty of this case will, I hope, be a sufficient apology for its introduction here. Calculous formations in the canaliculi and sac are not very infrequent, but I apprehend that such formations in the excretory ducts of the gland must be excessively rare.

TWO CASES OF INFLAMMATION OF THE TYMPANUM, WITH DEVELOPMENT OF POLYPUS; ONE ENDING FATALLY.

By JAMES HINTON, M. R. C. S.,

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I TRUST that the two following cases will not be without interest. The first exhibits the history of an ultimately fatal disease of the tympanum, as it was observed at intervals for some years before any threatening symptoms set in. Though post mortem details are wanting, yet the general character of the cause of death does not admit of doubt, and it is possible that the practiced eye may discern in my report indications of the serious character of the disease which at the time escaped my observation. At any rate, such were some of the previous symptoms, and such the final issue.

The second case was a striking instance of immediate and permanent relief given to very distressing symptoms of local and general irritation, and the renewal of polypoid growths, and the evacuation of retained discharge from behind them. I am induced to place the two cases together, possibly from a feeling that they constitute a natural contrast.

Case I.—*Chronic Disease of Right Tympanum, ascribed to a blow in childhood; repeated formation of polypus; death, with symptoms of extension of disease to the brain.*

W. L., æt. 35, of healthy constitution but intemperate habits, consulted me on Dec. 5th, 1864. Had been subject to attacks of severe pain and distress with discharge in the right ear since the age of eleven. The cause he believed to have been frequent boxing of the ears. Until three or four weeks ago the left ear had been fairly good; but at that time pain came on in it more severe than ever it had been in the right. Four years, and again two years previously, he had consulted Mr. Toynbee, who said there was a polypus in the right ear.

Since the affection which proved fatal arose in connection with the right ear, I may merely say, respecting the left, that a fibro-cellular polypus developed itself at the roof of the meatus, close to the membrane, which was thick but not perforated. Repeated inflation of the ear improved the hearing, the polypus was removed, and a lotion of Tinct. Iodin. (♏xx — ℥ i) employed, followed by astringents. Alum was applied to the throat and tonics given. The growth entirely disappeared and the membrane became natural; but the meatus remained prone to become irritable at times, and to secrete an excess of epidermis. Otherwise, the condition of the left ear continued satisfactory, with the exception of occasional and easily removed Eustachian obstruction.

The *right* membrana tympani was white, concave, and of a rigid look. There was a slight discharge from the meatus. A loud voice only heard. On blowing air into the nostril, while the patient swallowed, it entered the tympanum with a loud click, and the hearing greatly improved. (Watch, six inches.) Throat red and tumid, tonsils swollen.

Gargle of alum and ginger. Ung. Hydr. and pot. iod. around the ears.

The tympanum was again inflated, with slight improvement on the 6th and 8th, after which he was himself able to force in air. M. T. of a slight pinkish hue and less concave. A little discharge continued. The tuning fork placed on the head was heard pretty well; closing the meatus increased the sound. After a Turkish bath on the 10th, the hearing was worse again, and there was some resistance to the inflation of the tympanum, which was also less effective than before. On the 14th, after a crack in the ear, the hearing improved for a time. On the 16th the Eustachian catheter was passed; the air entered with a dry, rough sound, improving the hearing to five inches. The patient now went to Normandy. In June, after an offensive discharge for about a month, for which a lotion of permanganate of potash was used, a firm, fleshy mass, about the size of a pea, was syringed from the right ear. The discharge ceased for a month, and then soon disappeared again, under treatment by mineral acids and purgatives and a lotion of chlorate of potash and opium.

After six months (Feb. 28, 1866) I again saw the patient. The ears had been quite well and the hearing good ("almost too good," he said), until about 14 days. Then, without apparent cause, the left ear began to discharge, and the hearing on both sides became dull. Watch, each side, contact. In each meatus, at the internal part, there was some hypertrophy of the bony walls. The right membrane presented a pale red surface, of irregular aspect, in which the malleus could scarcely be distinguished. (Congestion and swelling, apparently, of the dermoid layer.) Inflation raised the hearing to six inches. After a month the hearing continued good; no discharge; the membrane had a dry, flat appearance, Eustachian tube pervious.

Shortly after he had a severe attack of delirium tremens; after

which, by his wife's account, he became quite temperate in his habits. He continued, however, to smoke about twelve cigars a day. I did not see him again for upward of two years, June 6th, 1868. The left ear was then fairly well, but he had had a little pain in the right at times. I found a fat, fleshy growth filling the bottom of the meatus, and a little pus escaped when the probe was introduced beneath it. It was touched with tinc. chlor. Air introduced by the Eustachian catheter passed, but not freely, *through* the membrane. Accordingly a few drops of a solution of pot. bicarb. (gr. vj—℥i) were syringed through the catheter with the view of facilitating the escape of matter. Lig. plumbi ʒij aq. ℥i to be applied warm to the right ear; powdered alum mixed with sugar to be blown into the fauces by means of a curved tube. I had from the first warned the patient's friends, that with his habits the disease of the ear might at any time become of a serious character, but at this time I detected no specially threatening symptom. He did not remain under my care, and the next information I received was that he had died ten weeks later (August 12th). On July 2d, he went to Dunkirk, still suffering from occasional pain in the ear, but seeming, in his wife's opinion, no way worse. At the end of the month (about three weeks before his death), he was exposed to a very hot sun, and complained of great pain in the head. He had looked ill a few days before, and had suffered increased pain in the ear after going into the sun or after smoking, but had never before spoken of pain in the head. He was at first treated for brain fever; leeches were afterward applied to the ear. No swelling over the mastoid process or elsewhere was observed by his wife. About three days before his death the discharge from the ear entirely ceased, and for the last two hours matter ran from the right nostril. He was not convulsed nor paralyzed. No post mortem was made.

CASE II.—*Inflammation of Tympanam, with formation of Polypi following scarlatina at twelve, and continuing forty years; frequent severe pains in the head, removal of Polypus and retained secretion; entire relief.*

W. I. B., æt. 52, a healthy man, consulted me on 26th March, 1867. Ever since scarlatina at age of twelve, had been subject to occasional discharge from both ears, with deafness, generally not severe, but at times much aggravated. In the left side there was a constant sense of discomfort, and the attacks of discharge were generally attended with pain in the ear and at the back of the head, which had lately become more severe. He could sometimes pass air *through* each tympanum. No tinnitus. A polypus had been long discovered in the left ear, but his medical attendant had declined to remove it, fearing lest irritation of the brain should ensue. On right side, watch heard on contact; left, a loud crack of the nail at three inches.

Right. M. T. red at the upper part; inferiorly it seemed thinned in patches, and a little below the center was a small orifice, about half a line in diameter. No discharge. Passing air through the Eustachian tube improved the hearing slightly. The left meatus was filled with a polypoid mass, which on examination appeared to consist of five, more or less, distinct growths. Of these, four were removed; one, which protruded nearly to the orifice, was of a bright red color, and had its origin from the floor of the meatus; and three others, of smaller size, which evidently grew from the internal wall of the tympanum. There was a fifth, but this was not touched. After the removal of the growths, a dirty white surface was exposed. This consisted of masses of inspissated discharge, several of which were removed by the syringe, aided by inflation of the ear—air passing very freely through the Eustachian tube. In fact, the tympanic cavity appeared to have been filled with this kind of

matter. After its removal, the watch was heard at half an inch. A blister was applied behind the ear and the exposed surface of the tympanum was cleansed and dried and dressed daily, for a week, with powdered talc to which a little morphia had been added. It rapidly assumed a dry and healthy appearance and the remaining polypus shriveled up. Immediately after the removal of the polypi the irritation abated; it soon ceased entirely and has not returned. The hearing continues (after 18 months) fairly good; the Eustachian tube is freely pervious, and the exposed surface, though tumid and of dark red color, is entirely free from discharge or tenderness. No vestige of membrane or ossicula is visible. Soon after the removal of the polypi from the left ear the *right* ear took on a slight attack of inflammation, and was for some days very tender and painful; the meatus being swollen and the Eustachian tube closed. This attack soon abated; and by the aid of lotions of sulphate of zinc, or borax, and opium, with alum to the throat, the hearing has improved; but the left has been the better ear.

EMBOLISM OF A BRANCH OF THE RETINAL ARTERY WITH HEMORRHAGIC INFARETUS IN THE RETINA.

By H. KNAPP.

About fifteen years ago the genius of Prof. *Virchow* predicted that, with the ophthalmoscope, embolism in the retinal artery might be directly seen in the living body. This suggestion was a fruit of his brilliant discoveries of the varied series of morbid changes, resulting from the obstruction of blood-vessels by thrombosis and embolism. Four years later, in 1858, Prof. *V. Graefe* observed the first case in which almost instantaneous blindness was caused by obstruction of the central retinal artery, in a patient suffering from indocarditis. Since that time several cases of this kind have been described, in all of which the symptoms observed tend to the supposition of an embolus, located *within the central retinal artery before its entrance into the eyeball.* Two cases only are on record where the obstruction took place *within the eye*, and was limited to one of the branches of the retinal artery. The first is that published by Prof. *Sæmish*, of Bonn, in *Zehender's Klinishe Monatsblaetter*, 1866,

p. 35, and accompanied by a chromo-lithograph, representing [in the inverted image] the blood-vessels in the upper half of the retina, and upon the optic disc as being in a normal state; the inferior principal branch of the retinal artery, however, displays a slight intumescence beginning just at the margin of the optic papilla, and extending thence about half the length of the diameter of the optic disc. From this point to the periphery of the retina, the artery appears as a thin white thread, and nearly the entire lower half of the retina itself has lost its transparence, and assumed a milky white tint. The field of vision was correspondingly curtailed, whilst the acuteness of direct sight and of that in the other parts of the visual field proved normal. The patient had noticed the defect two days before, and his habit to use this eye for taking aim with his gun is a proof that the defect did not exist previously. His general health was perfect, and the most careful examination could not detect any irregularity in his organs of circulation, in particular. The opacity of the retina disappeared very soon, but the state of the artery and the defect in the visual field proved stationary.

The second case is observed and reported by Dr. *Hirshmann* in *Zehender's Klin. Mon.*, 1866, p. 37. A patient with cardiac disease and articular rheumatism had, six months ago, noticed, when stooping, a sudden obscuration of his visual field. His sight had improved, but was still impaired ($S = \frac{1}{4}$). The lower part of the field of vision was failing as far up as a line of five centimeters below the point of fixation, the latter being one foot distant from the eye. The upper branch of the central retinal artery

had its normal width only in a short portion which lay nearest to the point of its entrance into the globe; its first divisions beginning at the optic disc, were extremely small, thread-like. Toward the equator of the globe, however, they grow thicker. The veins, the optic papilla, and the whole fundus of the eye displayed no other abnormity. The patient remained under observation for some time, had three times Heurteloup's leech applied, without producing any effect upon the visual field or the alterations of the retinal vessels, but the acuteness of direct vision improved from $\frac{1}{4}$ to $\frac{2}{3}$ of the normal.

To these two cases, I can add the following *remarkable observation of my own.* A case which I published in the Arch. fur Ophthal., XIV., 1, p. 217, as partial embolia was not considered by me to be an embolism of one branch, as Mauthner quotes it, but to be an incomplete obstruction of the trunk of the central retinal artery, the obstruction of the upper branch being more thorough than that of the lower.

Mrs. F. from Mannheim, aged 37, had since her last delivery, six years ago, been subject to repeated spasmodic attacks in her abdomen, pains in the region of the heart, irregular action and palpitations of the latter, combined with fever and pains in different places of the left side of her body, in particular hemicrania. All the time she would have painful swellings in her neck, lasting for twenty-four hours, bloody evacuations of her bowels, and pains in making urine, which, though being albuminous for some time, was always free from sugar. For these and part of the following particulars, I am indebted to the kindness of her family physician, Dr. *Stehberger.* What afflicted the patient most, were oppressions of the chest, which, setting in quite unexpectedly, would last from one to five

days, and bring on coughing, especially when a deep breath was taken.

Five months ago she had severe pains in the region of the heart, spleen, and stomach; pulse one hundred and twenty; increase of temperature, cardiac sounds impure, urine albuminous. Dr. *Stehberger* diagnosticated peri- and endo-carditis. This lasted at its height during nine days, then the symptoms abated, but aggravated again periodically. *The patient's power of sight* had been perfect until three weeks ago, when she, while reading, noticed that a *haziness was spreading over her book;* she tried in vain to wipe it away. Closing the left eye she found that the right had preserved its normal good sight; but on closing the right eye she could not see distinctly with the left, and every thing she tried to catch with the latter alone, appeared to be at a greater distance than usual. When she presented herself to me on the 20th of Feb., 1868, she stated that no change had taken place in the condition of her eye since she first noticed the disorder three weeks ago. I found the outward appearance, motion, and tension of both eyes normal, $S = 1$ in the right, but $= \frac{1}{8}$ in the left, by direct vision. The visual field had a *defect* which corresponded pretty accurately with the inner and lower quadrant, so that in this space neither the hand nor a candle was perceived. The apex of this triangular defect was directed toward the point of fixation without reaching it entirely, but lying from one to two decimeters beneath it. The limits of the defect were not sharply defined lines, but formed a small band of about one centimeter in breadth, in which the perception was only diminished. Vision in the remaining parts of the visual field was good.

The ophthalmoscopic conditions of the fundus of the eye are represented in Fig. 1, Plate A. They are drawn from the inverted image, and I shall describe them such as they appear. The reader will, therefore, please to remember that the directions are opposite, for

instance, the changes in the lower inner quadrant of the drawing are in reality those of the outer upper one, etc.

The optic disc was normal in the two upper thirds of its area, the center being whiter than the periphery, as usual. The principal branches of the central artery had normal width at their origin, and the upper branch remained so throughout its entire course, but the *lower was abruptly hidden from view* midway between the center of the optic papilla and its margin, *by a reddish gray opacity*, beyond which the retinal veins emerged in normal size; *but the arteries* showed most remarkable alterations. The principal branch, directed downward and inward, appeared extremely thin, like a fine red thread that could be seen distinctly only by a very accurate adaptation with the ophthalmoscope; this is continued for a distance about equal to the length of the optic disc's diameter; then it abruptly enlarged to about two-thirds the caliber of its corresponding branch in the superior part of the retina, obtained a double outline, pursued its regular course toward the periphery, dividing in secondary and tertiary twigs, just as in an healthy eye.

At the outer lower part of the optic papilla *the beginning of blood-vessels was distinguished by a short oblong swelling of a dark red color*, out of which came forth several finer branches that manifested themselves as arteries, by their light red color. Showing no abnormality in size or direction, they evidently must have conveyed arterial blood in a regular current.

By pressing with my finger upon the eyeball, I could produce pulsation in the upper division of the central retinal artery, but not in the lower. The fundus oculi, with regard to its vessels and other details, proved normal in both the upper and the outer lower quadrants, but the inner lower displayed very conspicuous alterations. The veins which were directed toward the yellow spot, and all those lying between the horizontal meridian and the principal lower venous trunk, *were enlarged and tortuous*. Most remarkable it was

that the *course of some of them could not be traced to the optic disc*, and only two very small communications between them and other veins were to be distinguished. *Numerous apoplectic spots* of smaller and larger sizes were scattered all over this triangular space, extending from the yellow spot in the apex toward the periphery, as far as the ophthalmoscope could bring it to view, its boundaries being the horizontal meridian and the principal inferior venous branch. Most of the hemorrhages lay around small venous twigs on both sides of the larger branches. Some formed broad patches in which immersed one or several smaller veins. The *retinal tissue had lost its transparency in the whole of this triangular space, showing a reddish yellow opacity.* The yellow spot was very distinctly visible. The retina around it resembled a semi-transparent grayish veil. *All the venous twigs descending from the superior half of the retina* were likewise enlarged and tortuous, but became normal in size and direction at some distance above the horizontal meridian of the retina.

The branches of the *main inferior artery*, that which was narrowed at its beginning, ran in a normal course through the whole region where hemorrhages existed, without giving rise to any extravasation.

The examination of the heart revealed a considerable increase of its size, and irregularities in the valves; the beat of the heart was most distinctly felt one inch and a half outward from the nipple; and in this place, also, percussion brought out a dull sound. The dullness preserved its usual limits upward, but inward and downward it slightly exceeded its normal extent. The sounds of the heart were impure, but no definite murmurs to be perceived.

The *treatment* was a general one, especially directed against the disease of the heart. The patient remained under my observation till October, 1868, that is to say, for eight months. During the first weeks there was no change in the eye recognizable with the ophthalmoscope,

but then a gradual absorption of the hemorrhages took place. They grew paler, first at their border, and disappeared without assuming any other color. I may especially mention that no white specks appeared upon or near the hemorrhagic patches, as is not infrequently seen during the period of absorption in other kinds of retinal hemorrhage. At my last inspection there was only one faint red spot to be observed, all others having disappeared. The retinal tissue, however, had not regained its natural transparency, but was like a tender whitish-gray veil. The arteries were in entirely the same condition as on the first examination, but the *veins of the retina had materially altered.* They were less tortuous and dilated, but not yet of normal size, least of all that branch directed toward the yellow spot. The ramifications which ran through the largest extravasations were still dilated, but less so than formerly, and their courses could be traced to the larger trunks in the direction of the optic nerve. *The acuteness of direct vision had improved to nearly the normal state, but the defect of the visual field had not changed in the slightest degree.*

CRITICAL REMARKS ON THIS CASE.

The diagnosis of endo- and peri-carditis, with subsequent increase of the heart, can not be doubted. The pains and disturbances in different parts of the body are to be explained by the supposition of embolisms in the smaller vessels of these organs; I mention in particular the left-sided headache, painful swellings in the neck, bloody evacuations of the bowels, and albuminous and bloody urine, *all of them* being well-known symptoms of embolism in the brain, the cutis or muscles of the neck, the intestines, and kidneys. I must abstain from entering more minutely here upon these interesting subjects, but refer the

reader who wishes to obtain deeper knowledge of them, to the classical researches of *Virchow*, published in his "*Gesammelte Abhandlungen*" and his "*Archives for Pathological Anatomy*," where also a good many valuable articles on the same subject, by other investigators, may be found. A complete description of embolic diseases is contained in *B. Cohn's* book, entitled, "*Klinik der Embolishen Gefässkrankheiten*, Breslau, 1860."

It is somewhat reluctantly that I indicated those references, the reliability of which has been demonstrated by numberless post-mortem autopsies, and is acknowledged by the most eminent pathologists and physicians.

Nevertheless, there has been much controversy about the origin of those characteristic changes, now known as being caused by thrombosis and embolism. In the department of eye diseases, in particular, this controversy is continued by some of the latest and most meritorious authors.

The complex of symptoms so characteristic in appearance, from its almost instantaneous commencement to the ultimate state of atrophy of the optic nerve, first described by *V. Graefe* as embolism of the central *retinal artery*, has been taken by *Fano* (Gazette des Hôpitaux, 1864, p. 482, and Annales d'Oculistique, t. 52, p. 239) and *Steffan* (Arch. f. Ophthalmologie, XII., 1, p. 34–65) for an *obstruction of the ophthalmic artery*.

The reasoning of the latter observer is as follows: "Since an abundant communication between the ciliary arteries and those of the optic nerve and the adjoining retina has been anatomically demonstrated, an obstruction limited to

the central retinal artery can cause a derangement in the circulation of the retina for a period only not exceeding twenty-four hours."

This assertion is not at all conclusive. We know that the collateral circulation in other parts of the body is not always so soon and sometimes never established in a degree sufficient for the integrity of the organ. The retina, in particular, requires an uninterrupted and abundant supply of blood, as is proved by the well-known experiment of *Donders*. When we exert but a moderate pressure upon the eyeball, so as to stop the circulation of the central retinal artery, then our sight immediately darkens, and is suspended until the impediment of arterial circulation is withdrawn. Nobody has ever explained the suspension of vision in this experiment as being produced by the bruising of the nervous substance in the retina, the consequences of which would certainly not disappear so quickly.

Moreover, I am able to demonstrate by this very experiment of *Donders* that, in cases of embolism, the impediment in the retinal circulation will last much longer than twenty-four hours. In the ophthalmoscopic courses I used to give at Heidelberg for the last seven or eight years, I first made the students thoroughly acquainted with all the phenomena of the healthy eye. With regard to this I engaged them to study the visible signs of circulation in the retina produced by pressing with their fingers on the eyeball. In this way I practiced that experiment a good many times on the healthy eye, and less often on eyes affected with various diseases; for instance, chronic glaucoma, in

the first stage of which disease such a pressing is very serviceable to ascertain the diagnosis, as everybody knows. I must confess, in contradiction to *Mauthner*, that I came across no eye in which I could not produce pulsation of the retinal artery, by a pressure so gentle that no individual complained of it. In such eyes only *whose retinal artery was obstructed by embolism or injury, I never could produce a visible beating of the retinal arteries during the first week.* As a rule, it was not before the end of the second week that pulsation could again be seen by applying pressure to the globe; and at this time, too, the caliber of the retinal vessels had regained half or two-thirds of its normal size. (See the observations I published on this subject in the Archiv f. Ophthalmologie, XIV., p. 209, etc., Cases I. to V.) The explanation of these conditions is this. As in all eyes pressure on the globe produces visible beating of the retinal arteries, the obstruction of the arteries only can frustrate the experiment; consequently, such obstruction may be safely assumed as existing whenever pressure on the globe fails to produce pulsation. I think this is plain enough, and I am therefore not a little surprised to find in *Mauthner's* valuable Text-book on Ophthalmoscopy the following passage (p. 345): "If *H. Knapp*, by pressing on an eye affected with embolism, could perceive no change in the conditions of either arteries or veins, it is impossible to draw any conclusion as to the manner of circulation from this unintelligible fact." I may here mention that I saw the veins, in cases of total obstruction of the central retinal artery, unchanged on external pressure, and this is natural

enough. When the retinal circulation is arrested, no blood will enter through the artery, and none flow out through the vein. Pressure on the globe, therefore, can not stop or slacken the exit of venous blood, and cause swelling of the retinal veins, as in other eyes. The symptom is witnessed in its purity during the first days after embolism took place. Far from considering it unintelligible, I think it constitutes a most valuable means of diagnosis, indicating not only the absence or presence of circulation in the retinal vessels, but enabling us to judge, to a certain degree, even on the strength of the current, by observing attentively the vigor of arterial pulsation and the amount of venous dilatation. If now, during the first two weeks of embolism, the retinal vessels are not only exceedingly small, but can not be made to pulsate by a pressure, which in every other eye will have such effect, then the arteries must be choked. And certainly there is a disturbance in the retinal circulation as long as the caliber and the pulsation of the arteries are not restored. This restoration is effectuated by the collateral circulation of the ciliary vessels, not during the first twenty-four hours, but after a longer lapse of time, and blindness, with ultimate atrophy of the optic nerve, is the result; only in exceptional cases of incomplete obstruction the retinal artery itself becomes permeable again, and perfect recovery may follow. (Case IV., Arch. f. Ophth., XIV., p. 217.)

On the other hand Dr. *Steffan* goes on saying that "the embolic obstruction in the above-mentioned deleterious cases must *include with the central retinal artery most of the short posterior ciliary arteries.* Some small vascular

channels of the short posterior ciliary arteries, however, must remain free, to account for the choroidal extravasation in the region of the yellow spot, and for the retinal extravasations near the optic papilla."

I agree with those who have asserted that far more marked changes should reveal themselves in the appearance of the choroid, iris, and vitreous, if most of the short posterior ciliary arteries were obstructed, since the nutrition of the interior parts of the globe is principally derived from these vessels. First, I must differ from Dr. *Steffan* in considering the dark red spot corresponding to the center of the macula lutea as a choroidal extravasation or as a hemorrhage at all. I have observed quite the same appearance in syphilitic and other forms of retinal inflammation, where no great tendency to hemorrhage exists. In syphilitic retinitis the latter is of rare occurrence, and wherever I saw it, it was accompanied by the usual radiating streaks around the optic disc. Hemorrhage, after total retinal embolism, does not only occur in close proximity to the optic nerve, but also in the region of the yellow spot. It is decidedly retinal, since the red spots are observed on the surface of the gray opacity which I saw in one instance cover the center of the macula lutea as well as its environs. Moreover, the red spots followed and covered the retinal vessels. The most striking case of my own observation is that of No. I., l. c., p. 209-212.

Let us now return to the case described in this paper. *How are the extensive hemorrhages to be accounted for?* First, we must notice that the extravasations were not sit-

uated at the border of the infarctus, but were plainly and distinctly visible in its center. The drawing shows that the hemorrhages are most abundant in the middle of the space occupied by the obstructed artery, and only a few and very small ones are at the border. These latter might be accounted for, in the usual manner, by collateral fluxion. In our case the hemorrhages *are venous*, *perhaps capillary in part*, but not at all arterial. To explain all this we shall trace the succession of the observed symptoms and discuss their causes and significance. The first occurrence is undoubtedly the sudden obstruction of the lower principal branch of the central retinal artery at the place of its first division. The *internal twig*, being completely choked, gave rise to all the pathological and functional disturbances observed. The *outer twig*, though enlarged at its origin, either remained or soon became open enough to convey blood through the minor twigs springing from it. The latter appear in proper color and size, and each of them is even larger than the choked portion of the principal lower retinal branch. No change of structure or function in that part of the retina belonging to these *outer inferior branches* having occurred, we must infer that the obstruction in the outer division of the lower principal branch was either incomplete from the commencement, or became so very soon afterward. The latter condition may have been brought on by contraction of the embolic mass, or by a sufficient anastomotic communication at this place. *The lower inner division* had at once and completely been choked. The patient had noticed the trouble in her eye

when reading a book. She said that after having read for some time in her usual way, she suddenly felt a cloud come over the page, and by closing alternately one eye after the other, she observed that the cloud was before the left eye alone. *The sudden approach of the disorder proves that the abnormality could not have been the consequence of a deep-seated inflammatory process*, for the supposition would be against all analogy that the symptoms of neuritis optica, or of any orbital inflammation should be felt by the patient in their full height in the course of one or several minutes without any premonitory symptoms whatsoever. Here we need not seek long for the explanation; the suddenness of the functional disturbance in conjunction with the endocarditis gives sufficient evidence of the embolic nature of the disease. Every other explanation that has been suggested (see *Stellwag's* Treatise on the Diseases of the Eye, translated by Drs. Hackley and Roosa, p. 665) appears far-fetched and improbable. Even *Mauthner*, who takes particular pains in searching for another explanation, comes to the same conclusion.

Now we shall consider another point of our case. *Is it not possible that the retinal hemorrhages were primary and occasioned the functional disturbance?* At the first glance through the ophthalmoscope they seemed fully to account for the defect in the field of vision, but on closer scrutiny we are brought to another conviction. First, it has never been observed that primary retinal hemorrhage leads to complete and almost instantaneous suspension of the retinal functions. Even in cases of most extensive reti-

nal apoplexy I always found a fraction of visual power remaining, and although dark spots to a certain extent obscured the visual field, yet there was never *a whole quadrant entirely missing* as in this case. Further we see that this is the very quadrant which was to have been supplied with blood by the choked artery. All this gives ample proof that the obstruction of the latter is the primitive phenomenon of the disease.

When did the hemorrhages occur, and what is their origin? We know that hemorrhagic infarctus in other organs, such as the lungs, kidneys, etc. (and ours may be called *a hemorrhagic infarctus of the retina*), are occasioned by embolism. In this case it has for the first time been directly seen in the living body. We recognized the place of obstruction; we saw, for a short distance, the artery extremely thin, although not entirely bloodless; we found, further, its caliber increasing at one definite point, and thence it branched toward the periphery in the usual way. This sudden increase of caliber may fairly be accounted for as the place of juncture between a ciliary and retinal artery. We know by modern researches that anastomoses between both systems will happen in this region, although they do not seem to be of frequent occurrence at such a distance from the optic disc. As soon as the obstruction in the retinal artery took place, the current of blood in the corresponding retinal veins must have been stopped, because the *vis a tergo*, which alone moves the contents of the blood-vessels, failed. The blood seems to have been driven out of the arteries by the contractility of their walls. Aside

from this explanation we may assume conditions to exist in the first stage of embolism similar to those of the approach of death when the motion of the heart stops. There we find the arteries empty and all the blood accumulated partly in the capillaries, but mostly in the veins. This blood is either stagnating, or merely gravitating, and constitutes in the latter case what is called cadaveric hypostasis. In our case the blood first stagnated in the retinal veins. The walls of the latter may have undergone some structural change, as a softening process, for want of nutritive supply and on account of the presence of old blood within them ; but this alone will hardly be sufficient to cause extravasation, since we either do not observe it at all, or merely in a very slight degree, in cases where the central retinal artery is entirely obstructed.

In our case we have to account for the following three remarkable facts that were observed in the retina : 1, *the dilatation of those retinal veins* which corresponded to the obstructed artery ; 2, *the origin of the venous hemorrhage ;* and 3, *the dilatation of the neighboring venous twigs.*

In cases of complete embolia of the central retinal artery, the *veins* have always been stated to be very small in their course through the optic disc and the adjoining part of the retina, *but increasing in size toward the periphery.* This fact may thus be explained. The contractility of the veins being greater in the larger branches, presses the blood out of those portions of the veins which are nearest to the optic disc, that is to say, nearest to the point of obstruction in the artery. In the neighborhood the cen-

tral retinal vein communicates with the orbital veins into which flows that small quantity of retinal blood which is pressed out by the contractility of the central portions of the retinal veins. In the remoter portions, that is to say, nearer the capillaries, the contractility of the veins decreases and the column of blood to be moved toward the next anastomosis gets longer and therefore heavier. Both conditions explain why the remoter portions of the retinal veins contain more blood than the portions near the optic disc, that is to say, near the next anastomosis. In our case, however, we did not only see a diminution of caliber in the central part of the retinal veins, but also a thickening, a beginning of varicosity, in the more distant parts. This may be explained as follows. As soon as the retinal artery was plugged, the blood contained in the corresponding capillaries and veins stagnated except that quantity which was pressed out by the contraction of the walls of the central portion of the vein. Had the system of circulation belonging to the obstructed artery been a separate one, having no communication, or at least an inefficient one, with the neighboring blood-vessels, there would have been no occasion for varicose dilatation of the veins. The retina as a whole, and certain other organs are in such conditions of a more or less isolated system of blood-vessels. As soon as the circulation ceases, the blood stagnating in the veins may be supposed to coagulate and choke the vessel to a certain degree. After some time, the nutrition of the veins and capillaries, as well as that of the surrounding tissue, being cut off, atonic collapse and softening set in. If then,

by continuation of the obstruction of the principal artery, and by want of sufficient anastomoses, the supply of fresh blood be any longer withheld, cadaveric changes—mortification, necrosis—will take place. When, on the other hand, a certain amount of arterial circulation is, as in our case, restored by anastomosis, then the capillaries and veins become filled with an undue quantity of blood, because the previous coagulation in the veins checks or prevents its natural outflow. The veins then being under a higher degree of internal pressure, become dilated, varicose; and, since their walls, as well as those of the capillaries and the surrounding tissue, had previously been softened, rupture of the vessels and hæmorrhage ensue. The arteries were not the seat of effusion of blood, by reason of their being stronger and of not containing any disoxidated blood that might soften their walls, thus offering a greater resistance to the renewed intravascular pressure.

The dilatation of the terminal branches of the neighboring veins may be ascribed to collateral fluxion, or explained as inflammatory hyperæmia—the morbid exudation from the vessels obstructed by coagula, diffused into the adjoining parts causing œdema and hyperæmia, which is seen in the vicinity of all irritative pathological processes.

How is it that the short portion of the artery between the plug and the entrance of the communicating ciliary branch could remain so narrow? Would not the blood flow backward as well as toward the periphery? The blood will always flow in that direction where it finds an outlet and a continuous current may be established. We may assume

that in the first moment the central portion of the retinal artery was also filled with blood which, finding no outlet, stagnated, and caused the artery to contract. The same phenomena are observed after ligatures of arteries; that portion of the artery lying between the ligature and the next preceding side branch will always shrink, although the blood could go down to the point of the ligature itself. The same condition is observed in the prolongation of a tied artery, between the ligature and the anastomosis next below. When there is no anastomosis at all, the entire prolongation of the impermeable artery will shrink, and in the length of time be metamorphosed into a solid cord. As the latter principally consists of connective tissue, scantily supplied with blood, it will appear like a white string. There could be no better illustration of such a fact than the above-quoted case of Dr. *Saemish*, which has erroneously been adduced as an evidence against the embolic origin of such maladies, and been taken for primary perivasculitis. Not only the history of the disease, however, pleads against the latter supposition, but also the restriction of the morbid change to one retinal artery and its abrupt termination on one definite point.

Thus far I hope to have been able to explain satisfactorily in our case the conditions of the fundus oculi revealed by the ophthalmoscope, and *to add to the many triumphs of this instrument another one, viz., the direct perception of a hæmorrhage in infarctus.*

The *progress of the disease* offered no phenomenon worthy of special notice, other than the *persistency of the*

defect in the visual field, while the morbid alterations of structure disappeared; the effusions of blood being gradually absorbed, the retinal veins becoming less dilated and tortuous, and the retinal tissue presenting only slight differences from the normal appearance.

This fact, however, is quite in accordance with the reports of all cases of complete obstruction of the central retinal artery; the function of the retina ever remains annihilated, although an efficient collateral circulation sooner or later set in to preserve the structure of the retina as far as ophthalmoscopic examination can discriminate it. Important structural changes, however, undoubtedly take place from the first moment of the embolia, and we have good reason to believe that the nervous substance of the retina can not, even for the short interval of time between the plugging of the artery, and the establishing of an efficient collateral circulation, be deprived of its wonted ample supply of arterial blood, without undergoing decomposition of its essential elements. Not only the abolition of the functionary power furnishes an argument for this assumption, but the ultimate atrophy of the optic nerve, which we witness in all cases of embolism of the central retinal artery, is another and more striking proof.

About the prognosis and treatment, there is little to be said in this disease. When the embolus plugs a branch of a retinal artery completely, permanent loss of function in the corresponding part of the retina seems to be the inevitable consequence, as the three cases known up to the present day demonstrate. The intercommunications of the

retinal arteries do not seem to be efficient enough to prevent the nervous elements from destruction, which manifests itself as a permanent loss of vision. The *treatment* can not be said to be very promising of favorable results. Nevertheless, I would not advise physicians to abstain from any treatment at all. As we know that successive emboli originating in the same source are apt to take the same direction in their course through the arterial channels, we must bestow particular care on the cure of endocarditis. Beside the medical treatment, repose of the body, staying in bed as long as endurable, and careful abstaining from every excitement, are strongly to be insisted upon, lest increased activity of the heart may detach new solid masses collected in the left side of the heart or the aortic system. Moreover, increased activity of the heart will increase the hyperæmia and hæmorrhage in the part supplied by the plugged vessel and in its neighborhood. If then we can not restore the full integrity of the affected organ, we may still be able to confine the extent of the pathological changes, and prevent new attacks in the eye, or any other important part of the body.

ON THE FORMATION OF CYSTS IN THE IRIS.

BY DR. L. WECKER, OF PARIS.

THE number of published observations on the formation of cysts in the iris, is already so considerable, that it is hardly worth while to add to them a new case, but that it will give us an opportunity to describe the manner in which these tumors are formed. In the second edition of my text book (part 1, p. 426), I have already been able to collect twenty-seven cases, to which must be added two cases by Hule, and one by Wordsworth, that have since been published (Ophth. Hosp. Repts., part 6, p. 12).

It will appear strange to every one who has seriously studied the pathological anatomy of the eye, that the iris, which is in such intimate relation with the choroid, should have the exclusive privilege of being the seat of cysts, which are hardly ever met with in the remaining parts of the uveal tract.

We are the more justifiable in being surprised at this peculiarity, as the iris, in comparison with the choroid, contains no elements which might predispose it to the formation of

cysts. Farther, we find in the texture of the iris no tissue which might occasion the formation of tumors of retention (for such without doubt are these cysts).

The case now to be described came under my notice in the summer of 1868, at my clinique, and the observation of this case gave me an opportunity to confirm the opinion which I had already formed with regard to cystic formations in the iris. The drawing (chromo-lith. plate A, fig. 2) represents the right eye of a woman thirty-two years of age, who, when a child of eight years had injured herself with a knife, from which there is still visible on the inner half of the cornea a scar six millimetres long, and forking upwardly into two parts. The vision was, as the patient states, "after the end of the first month, as good as ever," but in the course of some years it had become weak, and at the same time it was observed that a grayish film had spread over the pupil, and had almost completely covered it.

At present the right eye is slightly hyperopic 1-48, acuteness of vision 1-10, and the patient comes exclusively to ask us, whether it is not possible to remove the increasing film by means of an eyewash without an operation. The cyst has a grayish-white, transparent, gelatinous appearance, and forms a large heart-shaped diverticulum, to the inferior part of which a small, round, oblong body is attached. The pupil is, with the exception of a small slit, almost entirely covered, but dilates under the influence of atropine, so that its greatest expansion will measure about five millimetres in diameter.

The anterior wall of the cyst is continuous with the corneal cicatrix, and is slightly flattened toward the posterior surface of the cornea. With oblique illumination one may be convinced that the lens is not pushed backward; that the anterior chamber, in those parts not occupied by the cyst; has a normal configuration. The

trial of the power of accommodation could not be made, on account of the weak power of vision, and the limited intelligence of the patient. The patient would not at that time submit to an operation, as the deformity was slight, and the eye was neither inflamed nor painful.

A careful examination of this case hardly leaves a doubt that the cyst in this instance arose from the strangulation of the iris in the inner part of the wound of the cornea.

The statement of the patient as well as her relatives shows, that a long time after the injury the strangulated part considerably increased in size. Judging from the condition of the remaining portion of the iris, it seemed quite natural to suppose that in this instance we had to deal with a fold of the iris, which caught between the inner lips of the corneal wound, and caused the formation of a sac in this part of the iris.

I have already proved, in reporting another case (see my text book, part 1, p. 427), that a sacculation of a part of the iris may be caused by the attachment of a posterior portion of this membrane by means of a horse-shoe shaped posterior synechia. The analogy between the two cases observed by me was striking.

Nor can we understand what could induce *Hirschberg* (Arch. f. Ophth., vol. 14, part III., p. 295) to say, "that partial protuberance after irido-cyclitis with closure of the pupil, which Wecker enumerates among the serous cysts, might more appropriately be separated from this category, as such simple products of inflammation do not possess a really progressive growth."

It is my opinion that serous cysts are never developed in the iris, and the formations which have been called cysts are the results of sacculation of the iris.

The serous contents which they contain is the aqueous humor, and we may not unjustly classify these tumors, caused by sacculation with progressive distension and thinning of the iris, among the tumors by retention.

As soon as we consider the formation of cysts from this stand-point we can not distinguish between traumatic cysts and those formed by adhesions behind the iris after irido-cyclitis. A progressive growth is proper as well to one as the other, so long as the tissue of the iris is capable of secreting the aqueous humor into the sac formed by it, and this capability not destroyed by a too great thinning of the walls of the cysts, with subsequent atrophy of the vessels.

The inflammatory appearances which may be added to this progressive extension, result partly from the direct tearing of the iris, partly also from pressure upon the neighboring parts.

The anatomical researches of Bowman, Robin, and Van Kempen speak fully in favor of our view, viz., that the wall of the cyst is formed by the rarefied tissue of the iris, and that the uveal pigment, whose cells, more or less degenerated, and bereft of their pigment, forms the epithelial covering of the inner walls of the cyst. In describing the anatomical elements of such a cyst, *Hulke* says (loc. cit.):

"The cyst wall was a delicate homogeneous membrane, varying from $\frac{1}{4300}$ to $\frac{1}{4600}$ in thickness. Its outer surface was overlaid by a net-work of fan-formed cells, identical

with those of the contractile tissue of the iris; and its inner surface was lined by a pavement epithelium, the cells of which differed much in size in different parts of the cyst."

This structure agrees with the description given by Mr. Bowman (Lectures, p. 75, Lond., 1849), and with an observation by Prof. V. Graefe (Archiv, vol. 12, part II., p. 228). Notwithstanding, Hulke quite incomprehensibly comes to the following conclusion: "Since none (? !) of the elementary tissues constituting these cysts are normally present in the iris, they must, in this instance at least, be regarded as new formations, and not simply as distensions of already existing spaces, an alternative suggested by the result of Robin's and Van Kempen's examination of the debris of three cysts."

Our view only differs in one point from that of Robin, viz., in this, that the formation of cysts does not take place by the distension of a pre-existing space in the tissue of the iris, but that this space (a fold or sacculation of the iris) is caused either by injury or inflammation. It can not be denied that elements are sometimes found in the interior of the cyst, which are not normally met with in the iris. But we believe that this has only been caused by the injury. So it may happen that, as in the second case described by Stoeber, a cilia is found in the cyst, and it is not surprising that in a similar manner fragments of Decemet's membrane, the epithelium of the conjunctiva, or the epidermis covering the lower border of the lids, may be embedded in the fold of the iris.

We need hardly mention that we here exclude, with

Hulke, only one kind of cysts, and these are the hollow spaces which are apt to form in myxoma of the iris by the liquefying of the mass. How often, however, will we have a chance of observing these? The thirty-one cases of cysts of the iris which I have collected were almost exclusively serous cysts, a few cases excepted (V. Graefe, White, Cooper, Richard, Stoeber).

As regards the manner of their formation, Hulke says that in twenty cases, eighteen times injuries of etiological moment were mentioned. This circumstance alone, as well as the result of anatomical research which has discovered no new elements in the walls of cysts, are strong proofs that injury simply has given rise to a sacculation of the iris, and that the contents of the cyst are merely aqueous humor.

For those who still doubt that the iris can form such folds, we have only to draw attention to such peculiar cases of depression of the iris as were first described by Von Ammon.

Here a true inversion of the iris was observed, and if such an inversion of the iris toward the ciliary body is possible, are we not forced to admit that only a partial inversion of the diaphragm may give rise to the formation of a fold, and consequent sacculation. The possibility of this sacculation taking place by strangulation of the iris in a scar of the cornea, seems to be sufficiently well proven by the case we have described.

A CONTRIBUTION TO THE KNOWLEDGE OF CONGENITAL FISSURES OF THE LIDS.

By Dr. L. WECKER, of Paris.

Translated by J. H. & T. R. Pooley, M. D., of New York.

The number of cases of congenital fissures of the lids in medical literature is still so small that it is desirable to publish cases of such malformation whenever they are observed. There is the greater reason for this when such a case throws light upon the simultaneous development of similar malformations, and of the eye itself.

The case of coloboma palpebræ now to be described is the tenth which has hitherto been recorded, at least so far as our researches reach.

The nine preceding cases have been described by Mayer,*

* Thèse sur quelques maladies congénitales des yeux. Montpellier, 1808, p. 11.

Beer,* Heyfelder,† Von Ammon,‡ Cunier,§ Von Graefe,‖ O. Becker,¶ Horner,** and Manz.††

To the last of these authors belongs the credit of having written more thoroughly on the origin of this malformation and of directing attention to the frequent co-existing malformation of the surface of the globe of the eye.

The case described by Manz is also most important as throwing some light upon the mode of development of coloboma, since cutaneous bridges arising from the cornea of both eyes were extended between the congenital fissures of the lids toward the skin of the forehead.

Manz now puts the question whether this defect of the lids might not be explained by the remaining of these portions of the integument, the more so as in the phases of development of the lids there is no reason to be found for a permanent fissure.

The lids arise as similar folds of skin on the borders of the orbit, and grow over the already developed globe of the eye.

According to V. Ammon‡‡ the development of the lids and the later union of their tissues takes place about the end

* Das Auge, etc. Wien, 1831, p. 51.

† Zeitschrift für die Ophthalmologie, V. Ammon. 1831, p. 480.

‡ V. Walther & V. Ammon, Journal für Chirurgie und Augenheilkunde, Bd. 31, 1, II., p. 96. 1835.

§ Annales d'Ocul., T. vii., p. 10. 1842.

‖ Archiv für Ophthalmologie, B. IV., Abth. 8, p. 269. 1858.

¶ Arlt, Krankheiten des Auges, B. III., p. 376, Wien, 1858; and Med. Wochenschrift, Nos. 16–18, 1863.

** Klinische Monatsblaetter, B. II.. p. 180. 1864.

†† Archiv für Ophthalmologie, B. XIV., A. 2, p. 145. 1858.

‡‡ Archiv für Ophthalm., Band IV., Abth. 1, p. 15. 1858.

of the second month. Simultaneously with the formation of the lids and during their union, we are justified, according to the researches which have been made, to take it for granted that the cuticular covering which evenly invests the eyeball becomes transformed, by a histological metamorphosis, into the conjunctival covering of the globe and lids.

This portion of the skin participates more or less directly in the formation of the lids (conjunctiva palpebrarum).

Manz, in his paper, comes to the conclusion that the formation of coloboma of the lids essentially depends on an *abnormal histological transformation* of an originally normal connection existing between the anterior surface of the eyeball and the common integument, thus preventing the formation of a perfect upper lid. We believe it to be more in accordance with the laws which govern malformations in general, to ascribe the formation of palpebral coloboma simply to an arrest of development. We here have plainly not to do with an abnormal histological transformation, but with an *arrest* in the histological transformation; in other words, the cutis, which should be changed into conjunctiva, has remained as such to a greater or less extent, and for a longer or shorter time.

The proof of this assertion is found in the study of those cases of coloboma which are complicated with congenital malformations of the surface of the globe of the eye, such as pieces of skin, dermoid tumors, thickenings of the conjunctiva (lipomata?), and of simple corneal opacities.

The more marked the formation of the coloboma, the

more also that portion of the anterior covering of the surface of the globe which corresponds to the defect of the lid bears to the character of the cutis. We are enabled, therefore, as it were, by the study of these cases to follow the transformation of the cuticular covering into the conjunctiva.

The case of coloboma observed by us, and represented in Fig. 3, Tab. A, is that of a young man aged thirty, who in July, 1860, was brought to one of my consultations by a friend.

He himself did not consider the deformity of his eye, which had existed from earliest childhood, of sufficient importance to ask my advice. The right emmetropic eye of normal vision, which alone is affected with coloboma, exhibits on the upper lid, toward the inner part, a defect which is about 4 mm. high, and which is bounded by a delicate, finely corrugated, shining skin toward the margin of the orbit.

The edge of the lid is toward the lower angle of the coloboma, furnished with thick cilia. If we evert the upper lid we may easily be convinced that the upper tarsus, corresponding to the coloboma, is divided into two parts, of which the inner one represents a small triangular rudiment on which the Meibomian glands are distinctly visible. On the inner border of the cornea is to be seen a small slightly elevated dermoid tumor, somewhat pear-shaped and destitute of hairs. At the inner side of this cutaneous wart, directed toward the corneal tissue, was a whitish, crescent-shaped opacity, which resembled very much a partial arcus senilis.

On closing the eyelids, this cutaneous wart exactly filled in the notch formed by the coloboma of the upper lid.

It is worthy of notice that with the exception of the cases described by Cunier and V. Graefe, the coloboma

congenitalis has always been observed on the upper lid, whilst in the case described by Graefe, on the contrary, the coloboma existed on both lids of the same side; the case described by Manz is the only one which presented a congenital fissure on the upper lid of both sides.

If we compare the ten cases of coloboma which have so far been described, in order to discover what kind of malformations are simultaneously found on the surface of the globe, or on the latter itself, we see, according to Manz, Becker, and Horner, pieces of skin, more or less connected with the eyeball, insert themselves between the abnormal palpebral fissure.

In the cases of Mayer and V. Ammon, thickenings of the conjunctiva proceeded from the coloboma toward the cornea, in the shape of a third lid. The presence of a symblepharon after the union of the margins of the coloboma in Cunier's case seems also to indicate a similar pre-existing thickening of the conjunctiva. In the case of V. Graefe, as well as of V. Ammon, and my own, we find on the boundary of the cornea, corresponding to the defect in the lid (Graefe, Wecker), small dermoid swellings.

There remains only the cases described by Beer and Heyfelder, where there is no mention made of any co-existing malformation of the surface of the globe.

Beer, however, says that the transparent cornea was conical in form, whilst Heyfelder says that the upper segment of the cornea was flattened.

From this survey of cases it follows with certainty that until now the congenital fissure of the lid has not been ob-

served without co-existing malformation of the eyeball itself.

We should depart from the safe ground of direct observation, if at present we were to trouble ourselves with researches as to how far the persisting of a circumscribed part of skin upon the surface of the globe might more or less certainly become the cause of a fissure of the lid. From observations made it is evident that the arrest of this involution (or, more correctly, metamorphosis), may be more or less temporary, and be limited to so small an extent that no fissure of the lid results from it.

The by far more frequent occurrence of dermoid swellings on the edge of the cornea, without co-existing coloboma of the lid, is a certain proof of this. Highly interesting in this respect is the case described by Horner, where, upon one side, a central bridge of skin inserted into the cornea was complicated with coloboma, whilst, upon the other side, there were two principal dermoid swellings situated at the lower part of the corneal margin, without coloboma of the lids.

About thirty years ago Professor Riba had already asked the ophthalmic surgeons whether coexisting dermoid swellings of the globe had not frequently been observed in connection with congenital fissures of the lid.

This author believes that in consequence of imperfect or delayed partial closure of the lids, the conjunctiva takes on the character of the cutis and forms itself into cutaneous warts.

* V. Ammon's Monatsschrift, Bd. i., p. 658. 1838.

Now this statement is to be taken entirely in a reverse sense, and we arrive at the conclusion that the non-occurrence of the involution, or rather metamorphosis, of a circumscribed section of the skin of the eyeball, is the cause of the formation of dermoid tumors. And at the same time, if this arrest of transformation is of sufficient duration, or, extended to a sufficiently large degree, it is the cause of the formation of coloboma.*

As we are entitled to assume that the cutis covering the globe during the formation of the lid is transformed simultaneously to the conjunctiva of the globe, and the developing lids, we may without hesitation assume that an arrest of this metamorphosis is to be considered also as an arrest of development of the lids (conjunctiva of the lids).

We have therefore in the formation of a fissure simply an arrest of development.

* We beg, in cases where dermoid swellings are to be observed, that the lids may be very carefully examined, to see whether there be any indications in the outer integument, or in the conformation of the tarsus, which points to the existence of a coloboma during intra-uterine life.

CATARACT EXTRACTION OPERATIONS.

By HENRY W. WILLIAMS, A. M., M. D.,

President of the American Ophthalmological Society, Ophthalmic Surgeon to the City Hospital of Boston.

THE attempts to improve the results of operations for cataract, may be regarded as among the most notable of the endeavors made by the disciples of our modern school of Ophthalmology. Scarcely had flap extraction been everywhere accepted as the substitute for operations by displacement, before numerous innovations were proposed—each of them, according to the assertions of its authors and partisans, affording a previously unknown percentage of success.

Great advantage has already accrued from these praiseworthy efforts to increase the ratio of favorable results, and we can foresee yet greater benefits to be derived from the labors of so many earnest inquirers. Inspired by motives of generous emulation and loyal devotion to true scientific research, they have not hesitated, on the one hand, to discard some old traditions which have not borne the test of modern observation, nor, on the other, have they been too readily daz-

zled by the averred excellence of the results attained by certain new methods without taking into account all the elements which might have contributed to their success—or been disposed too hastily to generalize flattering statistics which may have depended on the special skill or experience of some operator, and thus to place too high a value upon certain maneuvers, without inquiry as to whether their alleged advantages might not, perhaps, have been obtained by other means.

Among the questions which seem to have been satisfactorily determined by these experiments, may be reckoned demonstration of the safety, and oftentimes the great advantage, of the use of anæsthetics in cataract operations. Among those as yet *sub judice*, and deserving of most careful and unprejudiced investigation, may be ranked some of the recently proposed modifications of operations for the removal of the lens, combined or not with iridectomy.

The fallacious value of temporary success is proved by the experience of almost every operator, who can adduce, here and there, a long sequence of invariably happy results,—but who finds his fortune changed, and his favorable average reduced in his next series of cases, although he pursues the same method, and exercises no less care and skill.

Even a wide-spread popularity has sometimes proved to have been undeserved. Only a short five years have elapsed since extraction by out-scooping, claimed as rendering success a certainty, was adopted by many of the most skillful and judicious operators in all countries, as an undeni-

able improvement in operative procedures. Yet, on a more extended trial, this favorite was left to neglect by even its most ardent admirers. Again we were assured that iridectomy, *per se*, was an almost absolute safeguard, and large portions of iris were excised without much regard to cosmetic effects, or to its uses as a diaphragm.

Time must show whether other new modes, yet more recently invented, are to be definitively accepted as truly conservative in conducing to the *permanent* recovery of vision, or are to be laid aside after merely ephemeral favor. Unquestionably the very best result, when attained without accident, is that which follows simple extraction of the lens, through a corneal section, without further mutilation of the components of the globe. Its principal dangers are well understood. The problem to be solved is, are these to be safely obviated by some or any of the new methods; or have these methods inherent dangers of their own, so that our attempts may perhaps be made, with more profit, in other directions.

Other things being equal, there can be no doubt that the farther the cicatrix of the incision can be removed from the ciliary region and the anterior of the choroid and retina, the greater the chance of ultimate safety, as these delicate tissues will be less implicated in any subsequent contraction. Sufficient time has not yet elapsed to enable us to judge as to the influence which operations through the sclera may have in causing separation of the retina; but it is reasonable to suppose, that, apart from any effect produced by the situation of the cicatrix, separation will be favored by the

loss of retinal support consequent upon the excision of a portion of the iris, especially if conjoined with a rupture of the hyaloid and diminution of the mass of the vitreous. This fatal change, supervening as it does only after a lapse of time, has perhaps not been sufficiently considered among the eventualities of extraction operations.

An incision in the sclera, combined with iridectomy, should certainly be expected to afford a ready exit to the lens; yet, practically, it is found, that after the section, as now made, larger portions of cortical substance are left behind, to be expelled by after manipulation, than in ordinary cases of flap extraction. This would indicate insufficiency of size of the section to admit of the easy escape of the lens. Yet, the incision can not safely be enlarged, inasmuch as it is already of such position and extent as frequently to allow the loss of a portion of the vitreous,—and as a large scleral wound would be liable to separation of its edges and a tardy union.

Unquestionably, flap extraction, by corneal section, as performed under the influence of anæsthetics, will bear favorable comparison with itself when done without their aid. Its maneuvers can be more delicately executed, with less contusion of the cornea and iris, than upon patients who, as formerly, were more or less intractable, or, at best, unable wholly to control the movements of their eyes. The lens may be slowly and carefully coaxed out, without fear of its sudden ejection in consequence of spasmodic compression of the eye by its exterior muscles, and fragments of cortical substance are less likely to remain within the

eye, or, should they be left behind, they may more readily be removed.

The advantages of the corneal flap extraction may be much enhanced, and its dangers materially lessened, in my judgment, by *the use of a suture to retain in apposition the edges of the wound.* Securing a more immediate union, we not only avoid ulceration of the border of the flap, and prolapsus iridis with its attendant evils, but the prompt restoration of the fullness of the globe, and of the normal relations of its several parts, lessen the chances of irritation, from pressure of any cortical fragments or remnants of capsule upon the delicate contiguous structures, and the occurrence of irido-cyclitis. This suture, a single strand only of the finest glovers' silk, passed through the edges of the wound by means of a very minute, short needle, held by forceps, can be tolerated, without detriment, even in the cornea; but at present I am disposed to extend the corneal flap at its apex a little way into the conjunctiva, so as to allow of the placing of the suture in this membrane, where it is more easily inserted than through the tougher corneal tissue.

Should experience approve the substitution of other modes of forming the section for those heretofore or now in favor, the suture may still find its application, in promoting the safe and rapid recovery of the eye, as it could equally well be employed whatever method might be preferred.

REPORT AND REMARKS ON A THIRD SERIES OF ONE HUNDRED CASES OF CATARACT-EXTRACTION BY THE PERIPHERIC-LINEAR METHOD.

By H. KNAPP.

Von Graefe has given us a full account of the principles and details of his new method of extracting cataract, which he now very appropriately calls "peripheric-linear." Not so exhaustively has he published the accidents and disturbances which are liable to occur during the operative procedure and the healing process, nor has he fully acquainted us, in the way of detailed statistics, of the primary and final results, and the necessary or desirable and feasible after-operations. The general practitioner is certainly more inclined to read only a summary statement of the results than a minute description of thé reverses of the method. But all who are engaged in ophthalmic surgery will be benefited by nothing more than an exact report of the unfavorable cases. If I were allowed to express myself figuratively, I should say: We are intimate friends of Graefe's operating room, but only casual visitors of his hospital wards. Certainly *Von Graefe* has not failed to give us a general out-

line of his statistics, and I am sure that only want of time has prevented him from presenting a detailed account of his unequaled experience, which would be of no less value than the description of the operative procedure; for the knowledge of the adverse occurrences is the origin of improvement. The proverb says: "Necessity is the mother of invention."

Having been among the first who had and took the opportunity to learn the method from the originator's hands and to try it on a large scale, I have already reported twice on one hundred cases each time, and am now about to add a series of a third hundred, all operated on by me during the summer of 1868. One hundred extractions constitute a fair number of cases which, when carefully watched in their course, can not fail to teach useful knowledge. With regard to the exactness and reliability of the following and my former statements, I may mention that my hospital wards have been always open without restriction to medical visitors. Hardly one operation has been performed at which there were not some competent witnesses present. The nature of the cataract and the accidents of the operation were always recorded by the first assistant surgeon having charge of the medical book-keeping on all the in-door patients. During the regular daily visits through the rooms, I examined, treated, and bandaged every patient myself, and had the necessary observations noted in the diary. The last examination, at the discharge of the patient, was always made by the first assistant, its results, as to the conditions of the eye and its visual acuteness, entered in the journal, and

afterward controlled by myself. In this way I possess the fullest notes possible on my cases, and can at any time have resort to my clinical journals. Having no claims to the invention of the method of operating I may be credited for impartiality in my reports. I dare say that I made all the particulars of the operation an object of unwearying studies, both theoretical and practical. An extended practice having given me some skill in its performance, the following statements may be considered as faithful and objective as they possibly can be made.

QUALITY OF CATARACT.

The quality of the cataract with regard to consistence, size, maturity, and composition (simple opacity, or fatty, chalky, and other degeneration), is of the highest import concerning prognosis and indications. The following statement is the summary of the observations I have made in these one hundred cases:—

69 *eyes had mature cataract* of either hard or soft consistence; 66 of them were operated on with full, 1 with a half success, and 2 were failures. The operations in the latter cases were without any accident, but two were followed by iritis, of which the former ended with a pupillary membrane, the latter became purulent and destroyed the eye. In the third case primary corneal sloughing set in. In five cases out of these 69, the operation was complicated with slight accidents; three times an escape of some drops of vitreous during the attempt of removing the remainders, twice pro-

lapsus vitrei before the exit of the cataract. These five cases all healed well.

13 *cases had immature cataract*, that is the *cortical layers* were partly yet of *normal appearance*. 10 of the 13 cases proved perfect results, 1 a failure, and 2 imperfect results. The operations, with one exception, were without accidents, and only in two a quantity of lens matter remained in the eye. In the one exceptionable case escape of vitreous happened before the exit of the lens, the cortical layers of which remained, to a considerable amount, within the eye. The patient was 80 years of age and operated on during the warmest days. The concurrence of these unfavorable conditions with the accidents of the operation, occasioned purulent iritis and destruction of the globe. Of the 2 cases of half-success one had been operated on without accident, but was followed by plastic iritis with a dense pupillary membrane; in the other I was not able to remove the lens matter sufficiently.

In 8 *cases the cataract was hypermature.* In 3 of them there happened prolapsus corporis vitrei during the operation, one of which was followed by iritis and proved only a half-success ($S=\frac{1}{60}$), the others were perfectly good results.

In the remaining 10 *cases the cataract was cortical only;* 9 of them resulted well. In the tenth the operation was without accident, the lens came out clear and complete, but after-hæmorrhage ensued. This caused chronic hyperæmia of the iris, and pupillary opacity, $S = \frac{1}{20}$ only.

The experience of this latter group of cases, as well as of similar ones operated on formerly, has satisfied me that the

maturity of the corticalis is far more important than the maturity of the nucleus. The nucleus, being opaque or not, will always come out without difficulty, if only the corticalis can be clearly removed. This may be done if the stripes adjoining the capsule are sufficiently opaque. I have extracted many such cortical cataracts in which the nucleus had hardly begun to show any turbidity. Cases in which the posterior cortical layer is opaque, the nucleus transparent, and the anterior cortical layer but slightly, if any, affected, commonly show an extremely slow progress, causing for a long time considerable impairment of vision. In former years I used to puncture the anterior capsule of such cataracts, and extract the latter, after the anterior corticalis or the whole lens had become opaque. Of late I have extracted the whole lens at once, taking care to lacerate the anterior capsule very freely, and to extract as much of it as I could. In one of the latter cases there was a circumscribed, dense opacity in the centre of the posterior surface of the lens, having an apparent diameter of about 7 millimetres. I succeeded in extracting the lens completely, but this posterior opacity remained behind. I thought it was a thickening of the posterior capsule, and, therefore, did not at once interfere with it. The eye healed, the opacity remained unchanged just behind the pupil. Some weeks later I lacerated it with a needle.

OPERATIVE PROCEDURE.

The more cases I operated upon, the more closely I followed the method of *Von Graefe* in its details. I may add

that this was not done out of blind imitation, but my own experience gradually forced upon me the importance of the rules insisted on by the author of the method. I made a good many trials, going as far as the safety of the patient would allow, but my routes nearly always converged to the same point which *Von Graefe's* genius and his greater experience had already arrived at. I shall point out some of the particulars of the operative procedure, the good results of which were further confirmed by the experience of this new series of one hundred cases, and express my views on what remains doubtful and unsatisfactory.

As to the *form and size of the knife*, the discussions of the Heidelberg Congress proved that I had already come to the same opinion which *Von Graefe* expresses so stringently in his last article (Arch. f. Ophth., XIV., 3, p. 116). "The knife should be as narrow as solidity will permit." By being narrow its passage through the anterior chamber, from puncture to counter-puncture, prevents the increase of intraocular pressure to any considerable degree, which might cause escape of aqueous humor. The deeper the chamber, the easier the knife is guided in the exact way intended by the operator, and even a false direction may be instantly corrected by drawing the knife backward as much as is required.

Endeavoring always to make puncture and counter-puncture as peripheric as possible, I sometimes observed that *the point of the knife became engaged in the iris.* This never took place at the insertion of the iris, but on some point of its anterior surface, mostly at the annular elevation produced by the circulus arteriosus iridis minor. When this

accident occurred I drew the knife backward until its point was disengaged, lowered the handle a little, and proceeded with the operation as if nothing had happened.

Taking great care that my knives were very sharp, I often had them at the instrument-maker's. By the repeated grinding, the end of some of the knives became so much thinned, narrowed, and pointed, that I failed to place the counter-puncture as peripherically as I had intended, because I could not longer see or calculate the exact position of the point of the knife when it was hidden behind the non-transparent peripheral zone of the anterior chamber. So it occurred that, while I was still pressing the point of the knife backward in order to get a peripheral counter-puncture, the point had already entered the corneal tissue more in front than I liked. The end of the knife being very thin and flexible I felt the resistance no sooner than I saw the blade being markedly bent. Sometimes I have been much afraid of the point being broken in this way. In order to rectify the false position of the counter-puncture, I withdrew the point out of the corneal tissue and turned it behind the sclerotic margin. When the blade is narrow and of equal size throughout its whole length, this correction may be made without the slightest escape of aqueous humor or any perceptible change in the conformation of the anterior chamber. If the point of the knife is not elongated, it will last longer, break less, and not require so extensive a drawing back in case its position should need correction. Morever, such a false direction is not so apt to occur because we see its end more distinctly than when it is threadlike. I think all these

advantages of a short point over an elongated one are appreciated enough in general surgery; but I found that, in the fabrication of Beer's cataract-knives, only the best instrument-makers in England paid due attention to them. The most appropriate shape of the knife for peripheral linear extraction I found at *Luër's*, in Paris. The blade is a trifle broader than 2 mm., begins to decrease in breadth 5 to 6 mm. before the point, but so slightly at first, that about 1 mm. before the end-point its breadth is still 1 mm. In this way a marked diminution of breadth for the purpose of forming the point is reserved to the last two millimetres. The back edge of the terminal portion of the blade is likewise sharpened as far as three millimetres backward. The surfaces of the blade are plain, and this I think more to the purpose than having them convex, the latter variety being less sharp, A somewhat hollow surface of the blades would increase the sharpness of the cutting edge, but soon find a limit by the danger of diminishing too much the durability and strength of the instrument already delicate enough.

About the section I have nothing new to suggest. I will only briefly repeat what I have said in my former report. On the surface of the globe, the whole section lies within the sclerotic. Its middle point is half a millimetre distant from the corneal margin, and, for large cataracts, extends so far laterally that perpendicular lines dropped from its extremities will touch the cornea as tangents. For smaller cataracts the middle of the cut remains the same, but its extremities do not reach so far laterally. I have expressed the reason for this rule in my former report (Arch. f. Ophth., XIV., 1, p.

291, &c.). Formerly I often placed the apex of the cut more toward the periphery. This, however, renders the expulsion of the lens difficult, and is apt to lead to prolapse of vitreous, without, as it now seems to me, preventing suppuration in a corresponding degree, so as to make amends for these drawbacks. Before the puncture, I determine with my eyes the location and size of the section, and try to hold the knife in such a way that its surface remains as much as possible in the same plane from the beginning to the end of its passage. By practising on the cadaver, I found that in this way the cut-surface becomes the most regular, whilst I sometimes was astonished to verify how irregular the section may be at its extremities, especially the outer, when the knife, in entering the anterior chamber, is held parallel to the plane of the iris. I have not a little improved in judgment on the means of obtaining a good section, and its qualities, by these experiments on the cadaver, affording a thorough inspection of all its irregularities.

Concerning the mode of excision of the iris, I have nothing to add to what *Von Graefe* says in his last article. I was acquainted with his views and practice on this subject by personal intercourse, and followed them in all the operations of this series. The iris is seized not in the middle of the wound, but somewhat nearer to its temporal extremity, gently drawn out and cut by three strokes of the scissors as close as possible to the borders of the wound. If then the sphincter edge of the coloboma does not spontaneously recede to its proper place, gently rubbing on the corneal edges of the wound with the hard india-rubber

curette is resorted to, until the pupillary edges of the iris are quite disengaged from the wound. The laceration of the anterior capsule, in all cases of mature and ordinary cataract, was done cautiously, but very freely, and in different directions. Whenever the capsule was thickened by deposits of any kind, I circumcised, with the cystitome, the part corresponding to the coloboma and extracted it. I succeeded in doing this, in some cases, with the cystitome itself, the point of which, after the circumcision of the thickened part of the capsule, was carried near the lower edge of the pupil, quite opposite to the apex of the cut, in order to catch the said portion of the capsule and drag it out. In other cases, when this procedure would not attain the desired effect, I extracted the loosened portion of the capsule by means of a pair of delicate forceps. I suppose that *Liebreich's* forceps,* with teeth at the convex side of its curve, will be very serviceable for extracting the anterior capsule.

In the art of *expulsion of the lens* I followed the procedure I advocated in my former report. While an assistant steadies the eye, the operator presses, by means of a flat spoon, the posterior lip of the wound backward, at the same time pushing with the india-rubber spoon, the lens through the opening. It seemed to me that the expulsion was the most facilitated in this way. In some cases of old, dislocated, or trembling cataracts I introduced a large, but rather flat, spoon behind the crystalline, and extracted it with the capsule. In the rare cases of prolapse of vitreous

* See his Article in the present number of these Archives, p. 22.

before the expulsion, I extracted the cataract with the same spoon, when the lens did not enter the wound readily by the pushing maneuver. I beg leave to say that I use a large spoon only for large lenses that fill it. They will then come out readily, with or without the capsule, even when adherent to the iris, in which case it mostly is unnecessary to break the synechiæ previously with a hook. Loose shrunken lenses or hard floating nuclei are best seized and extracted with suitable forceps.

ACCIDENTS OCCURRING DURING THE OPERATION.

Bad accidents during the performance of the operative procedure were less frequent than in the former two hundred cases, which I ascribe both to the improvements of the method, and to the acquirement of greater skill on my part.

Only twice there remained within the eye *considerable lens matter*, causing in one case purulent capsulitis, with $S = \frac{1}{20}$, but very good prospect for subsequent discision of the pupillary opacities; in the other case no inflammatory reaction followed, and the patient was dismissed fifteen days after the operation with $S = \frac{1}{10}$. Six weeks later, I performed discision of the pupillary opacities, which operation, in the course of 5 days, raised S from $\frac{1}{10}$ to $\frac{1}{3}$.

Hæmorrhage into the anterior chamber during the operation was not infrequent, but the blood was almost always evacuated at once by pressing gently on the cornea with a soft sponge; only in rare instances I was obliged to take the speculum away, lift the wound a little by means of a blunt spatula, and squeeze the blood out by rubbing with

the lower lid over the cornea. In all the cases I succeeded in getting the anterior chamber clear, so that I could dilacerate the capsule, while keeping constantly the point of the cystitome in view.

Prolapse of vitreous occurred nine times under the following circumstances:—

Twice it was only one drop coming out during the trials of getting the remainders clearly out. Both eyes healed without irritation, with $S = \frac{1}{6}$ and $\frac{1}{7}$ respectively.

Twice it occurred in eyes with shrunken cataracts. The first was calcareous and disciform in an old woman. Such cataracts are difficult to get out. In this case vitreous escaped during the pressure of the spoon on the cornea. I succeeded, nevertheless, in pushing the cataract out without being obliged to enter the eye with an instrument. Healing perfect; $S=\frac{1}{10}$ in an eye unhealthy apart from the cataract. The second case was a soft cataract, with many earthy and fatty deposits on the capsule. After the exit of the lens I tried to extract the anterior capsule, but in this attempt I ruptured the hyaloid fossa, and some vitreous escaped. This had the advantage to push the capsular opacities aside, and form a clear pupil. The patient had no trouble, and was very soon discharged with $S = \frac{1}{4}$. The *fifth* case was that of an excessively myopic eye, in which I presupposed the vitreous to be fluid and other changes present. I therefore extracted the lens with its capsule by means of a large spoon. The operation was done easily, and complicated with prolapsus vitrei only to a limited extent. The eye healed without trouble, but regained no higher

visual acuteness than $\frac{1}{40}$, on account of choroidal atrophy. In *two other* cases vitreous escaped before the exit of the lens by unusual pressing on the part of the patient. One eye healed well with $S=\frac{1}{10}$; the other, in which considerable portions of lens matter remained behind, was destroyed by suppuration. Both accidents, and the unfortunate termination of the latter case, might possibly have been avoided by using an anæsthetic.

The *two last* cases of prolapsus vitrei were brought about by slight dislocation of the lens with the cystitome. In former times I was more liable to incur this faulty step, of which other surgeons also are guilty even oftener than they are aware of, as I satisfied myself in seeing them operate. Although a slight dislocation of the crystalline is easily produced, when the section is peripheric and the zonula brittle, I think it may, with proper care, be reduced to exceptional instances. The two cases above mentioned did well, one obtaining $S = \frac{2}{7}$; the other, $S = \frac{1}{10}$.

Making a summary of all the operations in these one hundred cases, it ensues that there were eighty-nine operations executed without any accident whatever from the beginning to the end, and of the eleven operations accompanied with untoward accidents, four only can be laid to the charge of the operator. This is, I think, not an unfair percentage, but impresses, nevertheless, the writer of these lines very strongly with the conviction that further unremitting study, care, and practice is needed to perform every step of this admirable operation with the greatest possible neatness and safety.

COURSE OF HEALING.

The close observation of the healing process, after the operation, is instructive in the highest degree. Living in one wing of the Ophthalmic Institute, and not doing any out-door practice, I was particularly favored in watching my patients most carefully without losing much time by it. Twice a day I made the visit to the patients with the clinical assistants who were directed to take notes of every incident of any significance in the course of healing.

The diverse untoward circumstances which occurred after the operation were *after-hæmorrhage and inflammatory troubles.*

Six cases of the former are noticed. In the five first it occasioned no harm, and did not interfere with a speedy and favorable healing, the patients obtaining, respectively, $S=\frac{1}{4}$, $=\frac{1}{4}$, $=\frac{1}{8}$, $=\frac{1}{4}$, $=\frac{2}{3}$, after early discision of pupillary opacities in the latter. The sixth case, however, ultimately became the most distressing of the whole number.

Both eyes of a man, sixty-four years of age, and rather feeble in health, had cortical cataract. The left was first operated on without accident, and healed in the most pleasant way. Therefore the patient acceded gladly to my desire to operate also on the other eye, which I did without encountering any difficulty whatever. He felt well, and could see distinctly after the operation. During the night, however, he had considerable pain, and the next morning I found the anterior chamber filled with blood. The cornea looked clear, the wound was perfectly closed, and there existed but little redness of the conjunctiva. My expectation that the blood would

soon be absorbed was not realized. A moderate degree of irritation being kept up, and the blood becoming rather dark, I performed, the seventh day after the extraction, paracentesis of the anterior chamber, in order to let the blood out, which still filled two-thirds of the latter. As soon as the pupil was free, there was blood observed also in the vitreous. The healing went on slowly, and the patient was dismissed twenty days after the extraction of the cataract from his second eye. This was not yet clear in its interior, and showed $S=\frac{1}{20}$ with a perfect field of vision. The first eye was quite healed, and had $S = \frac{1}{4}$. A fortnight later the patient came back, having iritis of the eye last operated on, and again hæmorrhage into the anterior chamber. In a few days the blood disappeared, the eye beame white, and the patient went home again, hoping that now the eye was out of danger. Not a long time afterward he returned to me with a new attack of iritis, and this time in *both eyes*. He soon improved, and left the institution with tolerable sight in both eyes. At home the inflammation began anew, and I am informed that six months after the operation both pupils were closed, the eyes possessed good perception of light, but showed some slight diminution of tension. The patient refused, at this time, any further operation.

This most distressing case furnishes a proof that after-hæmorrhage, although having generally no bad consequences whatever, may in exceptional cases, lead to severe iritis, and even cause sympathetic trouble in the other eye. Whether the latter would have happened, if only one eye had been operated on, I am unable to tell, but this much is certain, that an eye recently operated on is more predisposed to respond to irritation from any cause than an entirely well-conditioned one. The greater safety of *Graefe's* operation for cataract gradually dispelled my fear of operating on

both eyes at the same time, or shortly after each other, and this just described case, is, out of 330, the only one I have to regret having operated on both eyes at so short an interval. But what operator would not feel justified in acting similarly under the same circumstances? The patient coming from abroad, with cataract in both eyes fit for operation, one eye operated on and healing without any irritation; should we not be allowed to operate on the other eye six days after the first, or should we wait, and how long? I do not think any rule can be laid down for such questions. There will always be some cases proving exceptional to every rule.

Now what is the cause of this after-hæmorrhage? In many cases I could positively ascribe it to some injury of the newly united wound. The patient had either hurt himself, or rubbed his eye forcibly, or done it some injury of a similar nature. Rubbing is certainly a most frequent occurrence with all freshly healed wounds, and it may be done during sleep quite unconsciously. While I am convinced that a large number of after-hæmorrhages are traumatic, I am just as satisfied that some cases, and certainly the worst of them, have another cause for the bleeding. Especially when the blood does not only fill the anterior chamber of the eye, but the vitreous also; moreover, when the effusions repeat periodically, then they certainly do not originate in the wound but in some portion of the uveal tract. How to foresee such a predisposition, how to prevent the ecchymosis, and which is the most effectual mode of its treatment, I am not prepared to indicate. The above

unhappy case is sufficient to cause me not to look any longer on after-hæmorrhage as a trifle, but to inquire after the patient's eye, constitution, and habits with regard to such a predisposition; moreover, to lead the after-treatment carefully, holding every excitement and restlessness as far from the patient as possible, nor dismiss him too soon from the circumspective control of an ophthalmic surgeon.

Among the different inflammatory processes following the extraction, iritis was the most common. It happened seven times in these one hundred cases. Since most of the failures and bad results are comprised in this series, I shall analyze them carefully as to the causes and consequences of the iritis.

Two out of the seven *healed* with perfectly good results, having, respectively, $S = \frac{2}{7}$ and $\frac{1}{5}$.

The first showed only slight iritic symptoms. Some drops of vitreous had escaped in the act of cleaning the eye from remnants. Patient left the hospital fifteen days after the operation. The second showed discolored, but dilatable pupil, and marked circumcorneal injection. Slight pupillary opacities with $S = \frac{1}{6}$. Discision nineteen days after extraction raised S to $\frac{1}{2}$.

Three healed with occlusion of the pupil.

The first was an old decrepit lady with gouty swellings of the limbs, and cataract in both eyes, which were operated on at the same time. One healed well, the other had severe acute iritis, terminating in closure of the pupil. In about six weeks the eye was free from irritation, of normal tension, with no protrusion of the iris. The pupil was clearing so that the fingers could be seen. The lady

was quite content with the one good eye, but the chances for instituting an artificial pupil were very promising.

The second was acute iritis in a woman seventy-four years of age ending with closure of the pupil, but good perception of light, and normal tension of the globe. Here, too, the chances of an artificial pupil were very great.

The third was the worst of the three. Acute purulent iritis healed with dense occlusion of the pupil and protrusion of the iris. Perception of light good. —T? In this state the patient was dismissed nineteen days after the operation. Four weeks later the inflammation had subsided, the pupil cleared up a little, and the anterior chamber deepened. She was able to count fingers near the eye. Three weeks later again, I instituted an artificial pupil by excising the central part of her pupillary membrane. She obtained a very beautiful central pupil, and left, nine days after this operation, with $S = \frac{1}{8}$, although the eye was still red. I do not doubt that her sight will be quite good when the inflammation, after the second operation, has disappeared.

Judging from this case, and others of my previous experience, I should do injustice to the results of this operative method, were I to insert the two previous cases among the failures. They will, therefore, appear among the imperfect results.

The two *failures* were destructions of the globe initiated by purulent iritis and so-called ring-abscess. The first was after a perfectly smooth operation, manifesting not the slightest reason to account for the fatal issue. Such cases will always puzzle the medical man very much. The second failure was a panophthalmitis too, brought about by the concurrence of several causes,—a frail woman, 80 years of age

—the hottest days of the exceptionally warm summer of 1868; and, above all, an impure operation—complicated with loss of vitreous and remaining of lens substance within the eye.

Four cases of capsulitis, out of these 100 of extraction, presented themselves and were quite remarkable.

The first was that of a whimsical old woman, who was operated on without accident, but some cortical matter was left. The eye got a little red, but the iris was fully dilated, the pupil rather opaque. In this state she could not be induced to stay any longer in the institute. She had no pain, and thought the eye might now take care of itself at home. So she left, ten days after the extraction, with $S=\frac{1}{20}$. At home she looked after her business which had been neglected so long. Six weeks later she came again, having one-third of the anterior chamber filled with pus. The pupil was still dilated with atropine which she had constantly instilled. I applied poultices on her eye. The hypopyon diminished immediately. The peripheral zone of the dilated pupil first cleared up, *while the centre was intensely yellow, like a circumscribed corneal pustule.* In five days the hypopyon had disappeared. Shortly afterward she left the institute with a hazy pupil, but with very good prospects for further improvement.

The second case was operated on without accidents, or remaining lens matter, in a woman of sixty-seven. She experienced pain in her eye the second night, had chemosis, hyperæmia of iris, the dilated pupil was filled by a yellowish gray, wrinkled membrane, in which there were some dark, free places. These symptoms went on slightly increasing, until eleven days after the operation hypopyon appeared, the iris became somewhat swollen, and there was one filiform synechia below. The hypopyon increased for a week, but was never higher than 2 mm. Then it diminished and disappeared, twenty-four days after the operation. At its place lay upon the iris

a small, reddish, convex mass, not unlike sprouting granulations. It shrunk gradually, and the patient was dismissed fifty days after the operation, with a dense pupillary membrane, being able to count fingers near the eye. Three months afterward Professor *Becker* performed iridectomy, which brought about a very clear pupil, and already, in the course of one week, S = $\frac{1}{8}$.

The third case was a good operation in a healthy woman. Under painless chemosis and dilated pupil, the latter grew hazy, and the patient left twenty days after the operation, free from irritation, with S = $\frac{1}{60}$, and the intention of having an after-operation performed in case the pupil should not sufficiently clear up of itself.

The fourth case was a stout man of forty-nine years of age. Operation was without accident, and seemingly with a clear pupil. This latter, however, showed itself filled the next day with a considerable quantity of swollen cortical fragments and pieces of capsule. The pupil was dilated, the iris discolored. Some synechiæ and hypopyon followed. These symptoms abated rapidly, the hypopyon disappeared, the pupil remained dim when the excitable patient got mental troubles, fits of mania, and hastened home, ten days after the operation, with S about $\frac{1}{15}$, but very good prospects of a satisfactory result

The latter case may be called *capsulo-iritis*, the inflammation of the capsule being decidedly the primary affection.

Diffuse inflammatory opacity of the vitreous was observed in three cases. In the one it occurred after the extraction of a hypermature cataract, with thickening of the anterior capsule by whitish-gray and yellow (connective tissue and chalk) deposits on its posterior surface. The operation was without accident. Wound closed rapidly, no abnormality of iris and pupil, anterior chamber a long time shallow, chemotic swelling of conjunctiva, and a gray, smoky appearance of the vitreous as in acute glaucoma. No pain or uneasiness of the eye. These symptoms began the third day, increased

slightly during the first week, then decreased; so that the patient was dismissed seventeen days after the operation. The redness and conjunctival swelling had nearly entirely disappeared, but the vitreous still looked misty, and S was only $\frac{1}{10}$. No doubt it will have become perfect in a short time.

The other two cases were in both eyes of an old lady with slowly progressing cortical cataracts. The anterior capsule looked somewhat thickened by irregular deposits of inorganic and organic substance. Both operations were very smooth, but there was a slow re-establishment of the anterior chamber, chemosis and smoky turbidity of the pupillary field and vitreous. No pain, no alterations of iris. Only very slowly the conjunctival redness and swelling disappeared, and meanwhile the pupil was traversed by a thin grayish film. Thirty-four days after the operation S was $\frac{1}{10}$ in either eye. Therefore discision was performed, and the patient dismissed five days later with $S = \frac{2}{3}$ in either eye.

The trouble in the former case may be called simple *hyalitis*, that in the latter *capsulo-hyalitis*.

One *eye was lost by primary suppurative keratitis.*

The patient was a decrepit, very anxious lady, eighty years of age, and operated on during the hottest time of July. The operation could not have been smoother and more regularly peripheral and linear. The apex of the wound was $\frac{1}{2}$ mm distant from the transparent corneal margin. The day after the operation there was some mucous secretion on the lint covering the eye, slight œdematous swelling of the border of the upper lid, some redness of the conjunctiva and chemosis. The anterior chamber was filled and clear, pupil and iris entirely normal, and vision excellent. At the external corner of the wound, however, was a whitish swelling—infiltration of the lips of the wound, about one-fourth of its whole extent, the other three-fourths being perfectly smooth and well

united. The infiltration did not yet encroach upon the transparent cornea, but was entirely limited to the sclerotic at both sides of the cut. I mention expressly that no iris or any other perceptible foreign substance lay in the corner of the wound. The progress of the affection was simple. Without marked pain, the white infiltration extended gradually over the whole section, then upon the cornea, proceeding one definite step downward every day, showing a pretty sharp line of demarkation which, like in gangrene of the foot, advances a little every day. When it had reached the middle of the pupil, which was on the fifth day, the lower half of the pupil was still beautifully black and afforded the patient good sight. There was from the beginning only a very low degree of that peculiar form of striped parenchymatous keratitis which we witness as a rule after peripheral extraction. In the way just described the entire cornea was destroyed by suppurative softening, and the eye shrunk under the symptoms of panophthalmitis. The patient was dismissed twenty-four days after the operation.

If we now recapitulate the different disturbances of the healing process worth noting, as far as they have some influence on the results of the operation, we find the following:—

Six cases of *after-hæmorrhage*, five of which not interfering with a speedy and perfect healing; in one, however, aggravation took place after the patient had left the hospital, and was followed by irido-choroiditis of both eyes, in one eye most probably of a sympathetic nature.

Seven cases of *iritis*, two of them healed well and with good sight, three had occlusion of the pupil requiring a second operation for instituting an artificial pupil, and two were lost by suppurative irido-choroiditis.

Three cases of *capsulitis*, healing with imperfect sight easily improved by an after-operation.

One case of *capsulo-iritis*, with but moderately good sight requiring an after-operation to obtain full success.

One case of *exudative hyalitis*, doing well.

Two cases of *capsulo-hyalitis*, doing well also.

One case of *primary suppurative keratitis*, eye being lost.

This statement gives a comprehensive survey of the reactive processes following this method of extraction. Let us inquire in what they differ from those of the corneal extraction, in order to find out which ought to be attributed as proper to the peripheral extraction.

First we see one instance of *true corneal sloughing*, as pure, complete, and terrible as ever it can happen after the ordinary flap-extraction. The old age and the excessive summer-heat may be alleged as having been productive of this bad result, but the example shows that pure corneal sloughing is not precluded by the periphericity of the section. Nevertheless it is a very rare occurrence after the peripheric operation. Since former observations are not so conclusive of establishing the point of origin of destructive suppuration of the globe, having not, as the present ones, been made so early after the operation, we must take all the cases of suppurative panophthalmia together. Of them there were three in this third hundred of cases, a higher percentage than in the two former hundreds. Still this is much more favorable than what I have experienced in previous years by flap extraction, especially in hot summer-time.

Next comes *the reaction of the iris*. Seven cases of iritis

out of a hundred operations is decidedly less than I have ever before experienced after any method of extraction; two cases out of the seven were only low degrees, so that only five cases of severe iritis remain, two destructive, and three requiring after-operations for restoring sight. This low percentage of iritis may be accounted for by the pure and broad iridectomy, especially by taking care that before the exit of the lens no part of the iris is left in the section.

After this we observe some *reactive processes which, I suppose, are more proper to this operation than to the corneal; I mean the capsulitis, capsulo-iritis, capsulo-hyalitis, and hyalitis proper.*

The clinical features of *capsulitis* have now come sufficiently often under my notice, to enable me to give a general picture of its symptoms after the notes in this and my former reports. As to its causes, I think the extensive tearing of the capsule, especially when the latter is changed in structure, acts in favor of the production of new cellular elements within the capsule. At the height of the process there is the greatest resemblance to corneal pustule or circumscribed abscess. This collection of pus was observed in the centre of the capsule, but I am not at all certain, whether those cases where the yellow discoloration appeared at the periphery of the coloboma, and which were registered as iritis, may not have had their starting point in inflammatory reaction of the capsule. The equatorial zone of the crystalline has a greater quantity of young cellular elements, is nearer to the nutritive channels, and may therefore be supposed more liable to reactive inflammation than the centre of the

capsule. I must again pronounce, as I have already done in my first report two years ago, what a benefit it would be to remove the anterior capsule by a fair procedure. Excision will be the only way, since tearing, which now is done most extensively, and, in some cases, has the effect that part of the capsule exudes together with the cataract, is a manipulation neither so appropriate nor so safe as excision would be. Clear cuts are easily borne, as we see in the iris, but tearing and bruising are detrimental hurts to any tissue or organ. Now, when we come to the practicability of excision of the capsule, there seems to be hardly any thing else conceivable than to cut or rend the capsule by a sharp, curved needle, cystitome, or hook, then seize it with delicate forceps (rather than with a peculiar modification of the needle or hook, as I have seen several contrivances for similar purposes), draw it out, and if necessary cut it off close to the wound.

That the inflammation of the capsule may extend towards the iris and towards the vitreous seems very natural, and is proven by direct observation.

Another group of consequences of this operation are deeper-seated affections; those of the ciliary processes, choroid, vitreous, and, secondarily, the retina. Hæmorrhage and *primary opacity in the vitreous* are rather frequent in this mode of operating, although I have noted, this time, but one case of hyalitis. This was, however, such a marked one, that it could not have been overlooked. Had I turned my attention more particularly to these deeper-seated changes, I should most probably have noted more of them. Their origin certainly lies in the proximity of the section to

the ciliary body and vitreous. The injury creates hyperæmia and its consequences, exudation and extravasation. These alone will pass away without damaging the eye, but when they are added to similar conditions in the membranes bordering the anterior chamber, they may make a total of inflammatory reaction, the consequences of which are commensurate with the number and dignity of the parts affected. That the involuntary or voluntary rupture of the hyaloid membrane, with protrusion of the vitreous into the anterior chamber or outside the eye, is another addition to the injuries inflicted on the eye by the operation for cataract, is self-evident. Not knowing beforehand what resistance each individual eye is capable of presenting to the unavoidable hurts of the operation, I do not feel justified to increase them voluntarily by another one (as *Hasner* does in his puncture of the hyaloid fossa); and, as everybody, I consider involuntary protrusion of vitreous to be an unfavorable complication.

Although these remarks have become somewhat lengthened, against my intention, I do not like to curtail them, since they are all based upon positive observation, and, as to me, may serve to others to understand more thoroughly the dangers and requirements connected with all the steps of this admirable, though complicated operation. The deeper our understanding is, the more to the purpose will be the different acts of the whole procedure; and I do not think it impossible that, by knowledge and practice, we may yet be able to perform extraction of cataract with the same degree of safety as the operations for artificial pupil.

TIME OF HEALING.

The average duration of the patients' stay in the institute was $14\frac{11}{100}$ days. They were dismissed as soon as the reaction from the operation had subsided, and the process of further clearing up of the eye and consolidation of the wound was judged unendangered by the usual external influences of light, locomotion, &c. The following data give a general insight into the time of healing. Out of the one hundred patients, fourteen were dismissed from the seventh to the ninth day (inclusively) after the operation, forty-six from the tenth to the fourteenth incl., twenty-nine from the fifteenth to the twenty-first incl., and ten from the twenty-second to the fiftieth.

The usual course of healing, therefore, did not even last a fortnight, whilst a protracted healing, from three to seven weeks, occurred in ten per cent., the greater part of which were dismissed during the fourth week.

RESULTS AS TO VISUAL ACUTENESS.

The visual acuteness of all the cases was determined the day before dismissal, that is, at the earliest possible date. This I beg the reader to take into consideration when judging of the results obtained. The given figures are primary results with a good chance of spontaneous improvement in all. In many cases I performed discision of pupillary opacities at an early period after the extraction, but never before the inflammatory reaction had subsided, the patient being in such a state in which he would have been dismissed

but for a secondary operation. Of this early discision I intend to speak at another time; I will only mention here, that none of the patients lost any thing by, or underwent a considerable degree of inflammation after it. Almost all cases healed quickly (commonly in five days), and gained very much by the operation, so, for instance, $S = \frac{1}{10}$ was nearly always raised to $S = \frac{1}{3}$ or $\frac{1}{4}$. The following statement of visual results is made *before a secondary operation*, and represents the visual power at a period when the patient's eye has not yet entirely recovered from the operation, but is only on a sure way to do so. The determination was made by looking at a distance in a moderately clear room in using Snellen's test type.

Number of Eyes.	Obtained Acuteness of Vision.
1	$\frac{3}{4}$
4	$\frac{1}{2}$
4	$\frac{2}{5}$
8	$\frac{1}{3}$
12	$\frac{2}{7}$
21	$\frac{1}{4}$
7	$\frac{1}{5}$
6	$\frac{1}{6}$
2	$\frac{1}{7}$
4	$\frac{1}{8}$
14	$\frac{1}{10}$
3	$\frac{1}{12}$
1	$\frac{1}{15}$
4	$\frac{1}{20}$
1	$\frac{1}{40}$
1	$\frac{1}{60}$
1	$\frac{1}{200}$
3	$\frac{1}{\infty}$*
3	0

* $\frac{1}{\infty}$ means curable blindness, or good perception of light in simple occlusion of the pupil. 0 means incurable blindness, with or without perception of light.

If we make larger groups, and consider all eyes, the sight of which is destroyed, as losses or failures, all those with S beneath $\frac{1}{10}$ as imperfect results, and those with S = $\frac{1}{10}$ or more as perfect results, we have losses, 3; imperfect results, 15; perfect results, 82.

Most of the imperfect results have been converted by after-operations into perfect ones, all (except two with deep-seated complications) were susceptible of becoming good results. Thus, I may *sum up the ultimate result*, that 3 *per cent. of loss*, 6 *per cent. of imperfect, and* 91 *per cent. of good success* were obtained.

CASE OF ORBITAL CANCROID WITH HISTOLOGICAL PECULIARITIES.

By H. KNAPP.

(See Tab. I. Figs. 1 and 2.)

MARG. MUENCH, sixty-two years of age, of Waldmichelbach, near Heidelberg, presented herself at my clinic, 7th of May, 1868, seeking relief for an orbital tumor. Besides this, she had at the left side of her nose a round, reddish lump, the size of a hazel-nut, slightly projecting over the skin which itself was involved in it. The neoplasma had existed for four years. I considered it to be a *common epithelioma*, extirpated it, and found the diagnosis confirmed by the histological examination. The wound healed well.

Six months previously, the woman had noticed at the inner canthus of the right eye, a swelling which, since that time, had considerably increased. It had the size of a bean, was hard to the touch, free from pain, projecting over the inner canthus of the lids, movable with the skin, which was involved in it, and exulcerated to a very small extent on its top. In the immediate neighborhood were different reddish nodules, the size of a pea, embedded in the integu-

ment of both lids. On exploring the orbital cavity with my finger, I felt that the above-described tumor continued backward, as an oval hard mass along the inner wall of the orbit, to which it was firmly attached, its basis being quite immovable. Small nodules were visible through the conjunctiva of the lids.

I believed the growth to be a cancroid similar to that on the nose, and thought an extensive extirpation indicated, since the woman was in good general health, and the eyeball itself yet unaffected. Though the comparatively rapid increase of the growth, its penetration into the depth of the orbit, and the immovableness of its basis on the inner wall of the latter did not seem to warrant a favorable prognosis, they were, on the other hand, good reasons why the complete removal of the pseudoplasma should at once be undertaken, lest deferring might render it impossible.

I performed the operation in the following way. From the root of the nose (Fig. 1, *a*) I made an incision through the skin downward till *b*, and upward till *c*. Then I introduced one of the blades of a pair of scissors into the conjunctival sac, first under the lower lid (at *o*), afterward under the upper (at *e*), and cut through the whole thickness of the lids, at right angles to their fissure. This done, I prolonged these last cut lines as far as the ends *b* and *c* of the two first incisions. In this way I had confined in a somewhat rhomboidal space all the suspicious swellings. The incision through the skin in no place approached any of the tumors nearer than three millimetres. The horizontal length of the wound reached from the root of the nose to the middle of

the lids, so that the inner half of either lid, and the skin of the right side of the nose, nearly as far as its back, had been taken away. I then dissected the parts confined in this space as deeply as I could feel any hardness in the orbit. The tumor near the nose reached over half an inch backward, and was closely united with the periosteum. To secure the total removal of the foreign growth as well as possible, I took away a considerable part of the periosteum of the inner orbital wall, and even a small piece of the bone, which seemed to be a little softened. The conjunctiva of both lids was removed with the tumor as far backward as the line of its inversion on the globe, thus leaving the latter covered by nothing but its own mucous membrane. The muscles of the eye had not been touched, nor any important part within the orbit injured, the lachrymal sac alone having been removed, together with the growth.

There was no considerable bleeding during the operation, and no vessel required tying or twisting.

I immediately went to work to cover the defect by a plastic operation, the plan of which will be understood by referring to Figs. 1 and 2. The object was to replace the deficient parts of both lids, in order to protect the globe. I formed two quadrangular lobes of skin, one superiorly on the glabella (Fig. 1, *a.d f c*), the other inferiorly on the cheek and temple (Tab. I., Fig. 1, *o g h b*). After having dissected them to their bases and stopped the bleeding, I united the line *a c* with the line *e c* by sutures, so that part of the lower margin *a d* replaced the removed portion of the upper lid.

In a similar way the flap *g o b h* was transferred toward

the point *a'*, the skin around which had been previously dissected from its basis. The remaining outer half of the lower lid was in this way to become its inner half. I united first the lines *o b* and *a' b* with each other, then the inferior border of the superior flap with the adjoining skin; thus the line of union *a' d'*, Fig. 2, was formed. At last I united, by sutures, the outer portion (*g'*) of the superior border of the inferior flap with the adjacent skin above (Tab. I., Fig. 2, *g'*).

In this manner I succeeded to complete the two eyelids, and obtain a pretty regular palpebral fissure. Moreover, the upper lid could be fairly raised, the tendon of the levator muscle having lost nothing but its inner expanse.

The wound healed beautifully. A small part of the lower inner section only (*a' o*, Fig. 2) gave way, which produced a slight eversion of the lower lid near the inner canthus. The patient was dismissed from the hospital nine days after the operation. She had preserved a healthy eye protected by movable lids. Five months later, when I left Heidelberg, the eye and lids were still in the same very satisfactory state. The palpebral aperture could be opened and shut without trouble, and the cicatricial tissue at the inner side of the eyeball did not impede the free movements of the latter. No trace of any relapse of the tumor was observable.

Although the foregoing account may not be found destitute of clinical interest, this, by itself, would scarcely have induced me to publish the case. The *microscopic examination* of the specimen, made by my assistant surgeon, Dr. *Fr.*

Pagenstecher, revealed such a peculiar composition of the growth, as to give an additional scientific value to this case. The morbid conditions of the tumor being invested with a high pathological interest concerning the question of carcinomatous disease in general, Dr. *Pagenstecher* thought fit to give, in Virchow's Archives of Pathological Anatomy, vol. xlv., pp. 490–500, a more detailed anatomical description of the specimen than our space would allow. This description is illustrated by two lithographic plates. I shall, therefore, give a brief statement only of the results of this research, derived from Dr. *Pagenstecher's* microscopical preparations, which I did not neglect to examine carefully myself.

The *epidermoid layer* of the skin was perfectly normal, not at all thickened, nor sending any prolongations into the layers of the corion. Its appendixes, the hair-follicles, the sudoriferous, meibomian, and sebaceous glands behaved normal too; the same can be said of the muscles, blood-vessels, and nerves; but a very conspicuous *system of canals* running through the connective tissue was brought to view. They were forming an irregular net-work, with frequent anastomoses in broad and sinuous nodal points, winding in all directions through the corion, entering into the vascular papillæ, and penetrating backward into the cellular tissue of the orbit. The average thickness of the utricles is 14μ [= 0,014 millimetres]. They possessed no special walls, but were well defined towards the adjoining tissue. Their calibre is filled with cells, colloid globules, and molecular masses. Some of the cells, especially those lying in the broad nodal sinuses, are very flat, their large nuclei and nu-

cleoli very distinct, not so their walls. The same arrangement of sinuous, winding canals, filled with flat and sometimes cylindrical cells, embedded in a loose connective tissue, was found in the orbital portion of the tumor. Numerous lymphoid cells are dispersed through the connective tissue, principally around the described tortuous canals and the blood-vessels. The smaller sinuous canals, filled with cells, communicate with larger ones that are mostly empty. Some of these are replete with *finely striated and granular masses* which do not themselves enclose any cell or colloid globules.

This system is sinuous canals, bearing the greatest resemblance with lymph-vessels, must indeed be considered identical with the latter, since nothing else could account for their existence. *The last-mentioned striated and granular masses*, plugging in different places the larger canals, *were fibrinous coagulations*, i. e., *lymph-thromboses.* The accumulation of epithelioid cells, filling all the smaller and some of the larger branches of the lymph-vessels, was occasioned probably by a proliferation of the epithelial cells lining the inner wall of the lymph-vessels. The colloid globules are degenerated epithelioid cells. In a very few instances Dr. *Pagenstecher* saw similar canals, filled with the same contents, surrounding the cutaneous *nerves* of this specimen, and anastomosing with the above-described system of degenerated lymphatic vessels.

He thinks that they are an analogon to the lymphatic sheaths around the blood-vessels described by Prof. *W. His* and others. In no part of the present specimen, however,

he found these perivascular lymphatic sheaths degenerated.

The foregoing explanation of this morbid growth has first been advanced by Prof. *V. Recklinghausen*, who found two similar specimens only, described by his assistant, Dr. *Koester*. Further investigations are needed to clear up the important question, whether the lymph-vessels are liable to be the origin of carcinomatous growths, and, if so, what is the rate of frequency of this occurrence. For the surgeon many important considerations arise from these observations. Is it possible to diagnosticate this peculiar form of cancer? What is its prognosis with or without extirpation? It seems that our specimen, and the two of Prof. *Recklinghausen*, are to be classified among those tumors which have been described under the names of *Cylindroma* and *Utricular Sarcoma*. The orbit, and especially the inner canthus of the eyelids, seem to be a favorite seat of these growths, since a comparatively large number of them have been found in this region. They all displayed a very pernicious progress, and invariably recurred after extirpation, a fact which may be accounted for by the insidious creeping of the pseudoplasma along the lymph-vessels, without producing circumscribed swellings at first. What does enable the surgeon to recognize the finest and last projections of such an evil? How far away from the tumor must he draw the demarkation-line of the tissue to be removed? The old rule of operative surgery, to take away, in malignant growths, as much as possible of the seemingly healthy surrounding tissue, ought to be regarded to the greatest extent, whenever

there is reason for supposing a growth to be a cylindroma, or of the nature of the case here described. The latter will be carefully watched, and if any thing of its further course should prove interesting, I shall not fail to report it.

Five months later, that is ten months after the operation, I was informed that no change had taken place in the patient's eye, nor in her general health, especially no local recurrence could be detected.

ALTERATIONS OF TASTE AND SENSIBILITY IN THE TONGUE BY THE APPLICATION OF AN ARTIFICIAL TYMPANUM IN A CASE OF LARGE PERFORATIONS IN BOTH MEMBRANÆ TYMPANI.

By S. MOOS M. D.,

Professor at the University of Heidelberg. *Translated by H. Knapp.*

In the Centralblatt für die Med. Wissenschaften No. 46, 1867, the following notice was given by me :—

"By the application of the artificial membrana tympani—Toynbee's complete plate—alterations of taste and feeling in the anterior half of the tongue may occur under certain conditions. These alterations are to be considered as symptoms of pressure, caused by the contact of the *outer* surface of the artificial membrane with the *inner* surface of the preserved upper remainder of the natural tympanum, resp. with the chorda tympani lying in this region."

In the following lines I shall communicate the particulars of this observation, and endeavor to give an explanation of the observed facts.

The case referred to is a lady, twenty-seven years of age, who suffered since her childhood from scrofula and discharge of both ears. Another cause of her aural disease was unknown to her. The latter had pursued till now an entirely chronic course. It was painless, with increasing deafness, and a very copious discharge, which was sometimes greatly offensive, from both ears. After stronger bodily exertions, now and then after mental excitement, the patient suffers from pulsating noises, especially in her left ear, while she feels free from any other subjective auditory sensation. Besides that, she complains of dullness and heaviness in her head, exacerbating, from time to time, to real headache, especially on her left side. Lately a high degree of deafness condemned her to a solitude which greatly depressed her mind. The examination revealed the following conditions, very similar on both sides.

Both external meatus very wide, rather straight, partly excoriated by the copious purulent discharge, especially along the lower wall; both membranæ tympani destroyed, with the exception of their upper and posterior marginal portions, which appeared reddish-gray and thickened; in the tympanic cavities a considerable quantity of fluid pus. When the latter was removed, the mucous membrane appeared like a luxuriously granulating conjunctiva. Nothing could be seen of the ossicles but the thickened short process, and this only indistinctly, on account of the swelled and opaque layers of the tympanum by which it was enveloped. Both Eustachian tubes were at first wholly impervious to inflated air. The patient behaved rather awkwardly at the beginning, and the air entered with difficulty and only through the catheter into the tympanic cavity. The tubes were rendered permeable for Politzer's method by repeated application of the catheter. Hearing-distance for loud voice direct on the right side one pace on the left; a watch was heard only when brought in contact with the right ear, instead of at thirty feet distance; on the left it was heard at three inches distance. Conduction of sound

through the bones of the skull preserved. The results of the examination with a tuning-fork were not precise enough for definite conclusions. The experiment with a double otoscope manifested only a weak transmission of sound from the patient's left ear to the ear of the surgeon. It was impossible to remove the pus collected in both ears, since each time that I tried to do it (even with the utmost precaution) distressing giddiness, vomiting, and fainting ensued.*

The cleaning of the hearing organ was effected by myself and the patient by means of a delicate painter's brush, which was repeatedly moistened with tepid water. The following *indications* for the treatment were derived from the above-mentioned conditions.

1. To clean the ears frequently after the method here described.

2. To remove the obstructions of the Eustachian tubes by means of the catheter, &c.

3. To combat the hyperæmia and swelling of the mucous membrane lining the tympanic cavity by alternate applications of different astringents. I employed sulphate of zinc, alum, and nitrate of silver. The latter was brought every now and then upon the morbid mucosa of the tympanic cavity through the ear speculum.

4. To try to improve the patient's hearing by an artificial membrana tympani, I could satisfy myself of their beneficial effects on both sides already during the next day.

* The same accidents, occurring instantaneously, I observed in a young man, fifteen years of age, when I was examining with a bent probe the motion of a polypus seated in the superior and posterior part of the tympanic cavity. The plate of the stapes, in this case, had probably been rapidly and vehemently forced into the vestibulum. Of late, *Czermak* has made the observation, in repeating the well-known experiments of Flourens, that vomiting followed after the section of the semicircular canals (Fenaische Zeitschrift für Medicin, vol. iii., p. 101.)

The treatment pursued in accordance with the three first indications improved the patient's hearing very much. Whilst a watch of thirty feet hearing-distance could be heard by the right ear at a distance of two inches, by the left at a distance of three feet, it was heard, with an artificial tympanum, at a distance of eighteen inches by the right ear, and at a distance of six to seven feet by the left. The patient felt very happy at being now able to understand ordinary conversation without any trouble. She made use of artificial tympanums alternately in one ear alone or in both together, and had soon acquired skill enough to introduce them herself. At the beginning I inserted large tympanums (of 12 mm. diameter) to fit into the large perforations, in spite of their tilting over at every application. Her hearing was most improved by their employment. But at length they caused strong irritation of the ears, so that she was obliged to replace them by smaller ones (of 9 mm. diameter), the plate of which was thinner.

The improvement of hearing proved most remarkable when the artificial membrane was introduced further inward than the remainder of the natural tympanum, and its outer surface was applied against the inner surface of the latter. With the ear speculum these conditions could be easily verified, and the patient very soon felt the necessity of applying it in this way, which she learned to do by trying until the situation described was attained.

Whether she had been successful with the manipulations or not she recognized by the good perception of her own voice and by a loud murmur; the latter symptom is accounted for by the increase of intra-auricular pressure caused by the instrument.

Towards the end of the treatment she directed my attention to peculiar phenomena which, indeed, she had already perceived at the beginning of the treatment, but which had lost their mere accidental character only after a longer period of careful observation. She related them with the following words:—

"After the insertion of the apparatus a feeling of insensibility began to take place at the posterior part of my tongue, and I had the sensation as if all was swollen, so that the tongue appeared very heavy in speaking. I thought there was some change of the tongue visible, but could see nothing particular when looking in a looking-glass. This sensation lasted during the whole day, as long as I kept the instrument within my ear, and even a full hour after its removal. All solid food appeared to be very smooth, without any roughness, even hard bread-crusts felt as if I touched with the tongue at the even surface of a piece of ice.

"Fluid substances of most different kind—wine, beer, sweet coffee, acid (she used to eat much salad at that time)—all appeared tasteless, I only had the taste of them in swallowing.

"The jaws, especially the left one, were somewhat heavy in speaking, as if a stiffness existed in them; at the same time I felt a continuous murmur in both ears, but my hearing was very good. The whole accident began half an hour after the application of the small apparatus, and I observed it about four to five times in four weeks, during which time I wore the artificial tympanum. When I wore the latter only on one side, the peculiar symptom was present only on that side, and with large apparatus it occurred more easily than with the smaller ones."

Two days before her departure I asked her whether she still felt that symptom, upon which she answered in the negative, adding, "when I now wear the apparatus in my ears I have a sick taste as if I were ill."

Unhappily I could not avail myself any longer of Professor *Helmholtz's* advice, to whom I communicated this observation, namely, to make experiments with powdered substances. Nevertheless I feel justified in believing the

minutely described phenomena of our patient as a valuable contribution to the physiology of taste.

EPICRISIS.

From our patient's communications it follows undoubtedly that, by wearing the artificial tympanum, she had repeatedly suffered from an anomaly of taste and feeling in the anterior half of the tongue. As long as the substances mentioned above had not been actually swallowed, they were indifferent to her organ of taste. We need not inquire here whether, apart from the root of the tongue, the anterior surface of the soft palate, or even its posterior surface, as well as the tonsils and the pharynx, participate in the perception of taste during deglutition. It is sufficient to state, in general, that the perception of taste existed as far as it could be attributed to an artificial anomaly of conductibility in those nerve-fibres which run into the tongue through the chorda tympani. Not only this anomaly of *taste* is important, but also that of *sensibility* in the tongue. If we make the concession that a complete anæsthesia of the anterior part of the tongue did not exist, then the sensibility of this region was certainly very considerably diminished. All that the patient ate appeared to her very smooth; for instance, hard bread-crusts were like pieces of ice. In general, we may, from this case, draw the conclusion that the chorda tympani collects not only fibres of taste, but also sensitive ones, a fact which is in accordance with the results of experimental physiology.

We have accounted for the named anomalies by the pressure of the artificial membrane upon the chorda tympani. Evidently a certain interval of time was necessary till the pressure, respecting the interruption of conductibility in the nerve-fibres concerned was complete, for the anomalies commonly manifested themselves only half an hour after the application of the instruments. That, on the other hand, the effects of pressure have been considerable, follows from the fact that the anomalies of taste and feeling in the tongue continued an hour after the removal of the instruments.

This observation has some analogy with the effects of the artificial tympanum on the restoration of the last conduction of sound through the osseous parts. In the successful instances of this experiment, the conduction of sound continues for a shorter or longer period after the instrument is withdrawn. [Compare my communications in "Archiv für Ohrenheilkunde," vol. i., part 2.]

The effect was uni- or bi-lateral, as the artificial tympanum had been applied on one side only or on both. It also was more intense after the introduction of larger and thicker instruments than after that of smaller and thinner ones; the pressure from the former being probably greater than that from the latter. The non-occurrence of the mentioned anomalies during the latest period of treatment, could not be dependent on a softening of the plates of the artificial tympanic membranes by their use, which rendered them incapable of exercising a sufficient pressure; for they proved efficient enough to produce such a pressure as was required for the improvement of hearing. Moreover, I did not suc-

ceed in reproducing the described phenomena by the use of new artificial membranes. Perhaps the chorda tympani had been displaced by the repeated use of these instruments, so that it was no longer, or not closely enough, in contact with them to cause the full series of symptoms as at the beginning. Perhaps, also, the nerves of the chorda had been blunted by the repeated pressure upon them. The perversity of taste and feeling which the patient lately alleged, may have resulted from some pathological change in the nerves hemselves, occasioned by their frequent contact with the foreign body. The difficulty of speech may be consequent to the diminution of sensibility in a similar manner, as we often find the motion of an organ impeded when its sensibility is reduced.

Later news which I received from the patient stated that her hearing continued to remain materially improved, while she observed only temporarily and in longer intervals the other anomalies above described. Once only the instrument reproduced the tastelessness and insensibility in the tongue with its former intensity, and that was after it had been out of use for some length of time.

APPENDIX.

Our contribution refers to a subject on which there is still much controversy. Professor Schiff, of Florence, who, as far as I know, has made on it the most recent inquiries, published, in Moleschott's "Untersuchungen," vol. x., pp. 406–422, experimental results contradictory to those of Lusanna and Inzani (Observations et Expé-

riences sur les Nerfs du Goût. Gazette Méd., 1864, p. 403), and to those of NEUMANN (Partieller Verlust des Geschmackssinns als Folge einer Otitis interna. Königsberger Medic. Jahrbücher, vol. iv., part 2, p. 340, and Moos' Klinik der Ohrenkrankheiten, pp. 244, 245). According to SCHIFF the second branch of the fifth nerve alone conveys all the fibres of taste, but they run for a short distance with the facial nerve; only part of them are given off to the lingual nerve by other anastomoses, as is especially the case in the dog and cat.

ISOLATED RUPTURE OF THE CHOROID, RESULTING FROM CONCUSSION OF THE EYEBALL.

By H. KNAPP.

(See Tab. I., Figs 3 to 4 A., and Tab. II., Figs. 4 B. to 9.)

THE bad effects of concussions of the eyeball have, undoubtedly, been noticed as long as there have been careful observers of eye diseases. Not a small number of cases are on record in which sight was impaired or lost after an injury to the eyeball or its surroundings, without any perceptible lesion of its tunics. Very different explanations have been given of these distressing consequences, arising from hurts apparently insignificant. The nervous system in general, the vaso-motor nerves in particular, the retina and optic nerve, it is alleged, have all suffered from injury and undergone minute molecular changes. All this is no more than conjecture. Whenever the blow has hit the orbital borders at the same time as the eyeball, which in most cases will have been inevitable, a fracture or fissure of some bony part at the base of the skull has been suspected. The broken bone may have lacerated or com-

pressed the optic nerve or the chiasma nn. opt.; or else the ensuing hæmorrhage may have made its way into the loose tissue, between the internal and external sheath of the optic nerve, and diminished or destroyed by pressure the conductibility of the nervous fibres; or the resulting inflammatory exudation following the injury may have involved the optic nerve or the chiasma. These assertions are not entirely hypothetical, but have, in rare instances, been demonstrated by post-mortem examinations.

More frequently, however, the ophthalmoscope reveals that the cause of the impairment of vision after concussion of the eyeball is a *rupture of the choroid*, rarely combined with laceration or detachment of the retina. A great many observations regarding concussion of the eyeball made before the discovery of the OS have now lost their value. True it is, indeed, that blindness or impairment of vision has been observed after a blow on the eye, in cases in which neither the external nor internal coats presented any change even upon the closest scrutiny of competent ophthalmoscopists. As far, however, as my own personal experience goes, such cases must be extremely rare. I do not, at this moment, recollect one single case of concussion with noticeable impairment of vision, where I could not see some definite change within the eye, or where there was not a combination with such cerebral symptoms as to indicate a deeper-seated lesion.

Since isolated choroidal rupture has not yet been made the subject of a general description, except briefly in some recent text-books, I will insert here a tabular statement of

the cases of this lesion recorded up to the present day. To these I shall add eight cases from my own observation, of which I possess drawings. The description will be inserted among the general remarks on the subject; at such places as their peculiar features serve to illustrate.

Tabular Statement of the Cases of Isolated Traumatic Ruptures

No.	Reference.	Year.	Nature of Injury.	Time after when first examined
1.	Von *Graefe.* Arch. f. Ophth., I., 1, p. 402.	1854.	Violent injury occasioning fracture of os nasi, contusion of lids, and impairment of vision. Central scotoma Large type made out with difficulty.	Some weeks.
2.	Von *Graefe.* Ibidem.	1854.	Injury.	Long time.
3.	Von *Ammon.* Arch. f. Ophth., I., 2, p. 124.	1855.	Suicide by discharging a musket, loaded with water, into his mouth. Death immediate.	*Necropsy* four hours later.
4.	*Streatfeild.* Ophthal. Hospit. Rep. II., p. 241.	1860.	Violent blow with a shovel on the temporal side of the orbit.	Six months.

of the Choroid as recorded up to the Present Time.

Symptoms.—Course.—Results.
Choroidal hæmorrhage in vicinity of opt. disc, disappearing in the course of some weeks. In its place a shining, white streak, with sharply-defined dark edges, encompassing a rhomboidal space around the opt. disc. Retinal vesseis could be traced over the rupture, *one branch only was interrupted.* Six months after first examination the same appearance of fundus. S as in the beginning.
Great amblyopia, strabismus internus. A very bright stripe running from the opt. d. *inward* through the fundus. $\frac{1}{4}$ D broad, 5 D long. Edges rusty brown. Retinal vessels branching over the white stripe.
Above the yellow spot the retina somewhat raised in a form like an elbow and directed outward. Just behind it the choroid was lacerated, showing a wedge-shaped rent some lines in length. *The edges of the rent not gaping.* No extravasation of blood other than some small streaks between choroid and sclerotic.
$S = \frac{1}{100}$. Deep glaucomatous cup. Above the opt. disc, two marks concentric with its margin; the nearer and larger one having a curve of about a quarter of a circle. Vision had improved after a short stay in the hospital.

Tabular Statement of the Cases of Isolated Traumatic Ruptures

No.	Reference.	Year.	Nature of Injury.	Time after, &c.
5.	*Frank.* Ophthal. Hospit. Rep., III., p. 84.	1860.	Blow on right supra-orbital region.	Eleven years.
6.	*Saemisch.* Zehender's Angenheilkunde, p. 751. (With a chromo-lithograph.)	1864.	A piece of wood struck the eye.	One week.
7.	*Saemisch.* Ibidem, p. 752.	1864.	Piece of wood thrust against the eye.	

Some years after the hurt the patient was able to read the middle-sized print of the attestation paper for the military service. At the time of the examination opt. disc whiter and flatter than natural; arteries contracted; retina slightly hazy; a gray patch below the opt. d.; Mac. lut. surrounded by diffusely infiltrated retina. From the opt. d. start two white, freckled, sharply-defined bands, the one upward and inward to the limits of the fundus oc., visible through the ophthalmoscope. The retinal vessels cross it, and the upper border is skirted by black pigment. The adjacent choroid studded with white and black specks. The other band runs upward and outward, has the same character as the first, and is surrounded toward the periphery by a perfect spray of choroid alternations. The sight of the eye was reduced to the perception of the strongest light only. Strabismus had been developed. *Frank* says that there can be no doubt that the white bands represent cicatrices after isolated rupture of the choroid. The diffuse retino-choroiditic changes are the result of the former lesion.

Mydriasis of middle degree. Media transparent. Three curved, white streaks, the one between opt. disc and yell. spot, the two others beyond the latter; all slightly concave toward the opt. disc. Some hæmorrhagic spots. Central $S = \frac{1}{6}$. Central scotoma corresponding to the largest of the streaks. Gradual absorption of the effused blood. Ten weeks later, streaks in the same condition as on the beginning. $S = 1$. Scotoma disappeared.

On the outer side of the opt. papilla, a slightly concave, vertical stripe, its upper end dividing into two branches. On the mac. lut., a vertical stripe of 2 D in length. Retina not torn. Vision remained impaired after cicatrisation of choroidal rents.

Tabular Statement of the Cases of Isolated Traumatic Ruptures

No.	Reference.	Year.	Nature of Injury.	Time, &c.
8.	*Schweigger.* Lectures on the Ophthalmoscope. Berlin.	1864.	Contusion of sclerotic by discharge of small shot.	
9.	*Haase.* Zehender's Klinsische Monatsblätter. 1866, p. 255.	1866.	Violent blow on the eye from a foreign body.	Soon afterward.
10.	*Saemisch.* Zehender's Klin. Mon., 1866, p. 111.	1866.	Piece of wood flew against the eye.	A few days.

Through the ophthalmoscope sclerotic denuded appearing as a bright speck surrounded with black pigment.

Lids much swollen, the upper one lacerated; lower orbital margin fractured; great chemosis, rendering an examination of the eyeball impossible. A week afterward swelling considerably decreased, iris tremulous, *lens dislocated* downward and outward. Optic disc somewhat veiled; toward the yellow spot a crescent-shaped, vertical streak at whose extremities two smaller excentric ones. Retinal vessels unchanged. Inconsiderable hæmorrhage. Scotoma inward (?) and upward. Four months later, streaks as before, skirted now with black pigment. Scotoma stationary. $S = \frac{1}{10}$.

The injury was followed by great pain, swelling of the lids, and loss of sight. Subconjunctival injection. Tn. No lesion of the external tunics; anterior chamber half filled with blood; pupils dilated, immovable; S reduced to mere perception of light, and lost in the inner half of F. In the course of five weeks the blood in the anterior chamber was absorbed, lens healthy, some blood in the vitreous. At the background two small, whitish-yellow vertical streaks, the one between yellow spot and opt. disc slightly concave toward the latter, the other one, beyond and near the yellow spot, surrounded by bloody specks. Retina uninjured, its vessels running over the streaks. Sight improved to the capacity of counting fingers at six feet distance. Seven weeks after the injury I 2 was read with ease, but some weeks later the central S again diminished (the result of retinal changes during the process of cicatrisation of choroid). Dark specks at the borders of choroidal ruptures. Some months later central $S = \frac{1}{100}$. *Small detachment of retina* in region of yellow spot. Ultimately $S = \frac{1}{60}$; detachment of retina as before; excentric S normal; no metamorphopsia.

Tabular Statement of the Cases of Isolated Traumatic Ruptures

No.	Reference.	Year.	Nature of Injury.	Time, &c.
11.	*Stellwag.* Diseases of the Eye, translation into English, p. 227, with a chromo-lithograph. Fig. O.	1867.		
12.	*Saemisch.* Zehender's Klin. Mon., 1867, p. 31.	1867.	A thong of a balance-wheel struck the left side of his face without hurting the eye apparently.	Twenty-three days.
13.	*H. Wilson.*	1868.	Blow.	Some months.
14.	*Mauthner.* Ophthalmoscopie Wien., p. 446.	1868.	Unknown.	A long time.

SYMPTOMS.—COURSE.—RESULTS.

In the region of the yellow spot large rent dividing above and below into two serrations. Two smaller streaks beyond the yellow spot. Retinal vessels running across the streaks.

Soon after the injury suggilation of lids and impairment of S. At the first examination nothing abnormal externally on the globe. Slight diffuse opacity and blood coagula in vitreous. Opt. disc and posterior part of background normal. Downward and *beyond the equator* circular detachment of retina $= \frac{1}{8}$ D in diameter. Ecchymosis and several ruptures of retina in the same region; two small ruptures of the choroid besides; all best recognizable as such by the binocular ophthalmoscope. All the lesions were at the limits of the fundus visible through the ophthalmoscope after dilatation of the pupil with atropine. Two months later S nearly normal. Defect of F persisting.

Two crescent-shaped white stripes, one above, one below the opt. d.; nearly concentric with the circumference of the latter. Some pigment spots within the white stripes; retinal vessels branching over the latter. A third smaller one beneath the lower stripe. Distance from the opt. d. margin of the upper larger stripe $= \frac{3}{4}$ D, breadth $\frac{1}{2}$ D, length 5 D.

Vertical white streak, skirted with black pigment, on the external side of the optic papilla; $\frac{1}{2}$ D in breadth, 4 D in length.

Tabular Statement of the Cases of Isolated Traumatic Ruptures

No.	Reference.	Year.	Nature of Injury.	Time, &c.
15.	*Mauthner.* Ibidem.	1868.	Blow with the fist.	**Seventeen days.**
16.	*Mauthner.* Ibidem.	1868.	Blow on the external part of the globe with the handle of a shovel.	**A short time.**
17.	*Mauthner.* Ibidem.	1868.	Stroke from a hoof of a horse on orbital region.	**Three months.**

No visual defect. Refracting media perfectly transparent. Slight ecchymosis on the background. ½ D above the opt. d., a choroidal rent running horizontally outward as far as the yellow spot, dividing into two branches in its inward prolongation, reuniting and curving downward at the inner side of the opt. d. On the outer lower side is a "counter fissure" turning its concavity toward the opt. disc. Retina uninjured, slightly troubled. Patient withdrew from observation some days later.

S=$\frac{?}{30}$. Media clear. On the outer and lower side of the opt. disc, a light-yellow curve, 1½ D in length, concentric with the margin of the opt. disc, and 1 D distant from it. A great many fine, light lines radiated from the borders of the fissure into the choroidal tissue. Below the external border a hæmorrhagic spot. Retina intact; its vessels branching free over the rent.

One large *horizontal* rent in choroid, 2 D below the opt. disc. Large retinal vessels crossing it.*

* Besides these seventeen cases two others are described by *Hirschler*. Wiener Medic. Wochenschrifh, 1866, Nos. 91, 92, which I was unable to consult, making a total of nineteen cases on record.

Among about 18,000 cases of eye diseases which came under my observation, I met with and diagnosticated, beyond the possibility of doubt, móre than one dozen of isolated ruptures of the choroid after a hurt on the eyeball; but I feel inclined to believe that a great many more cases which are reported in my journals under different names, such as traumatic intraocular hæmorrhage, traumatic iritis and iridochoroiditis, ought to have been classified under the head of choroidal ruptures.

The following observation may prove this assertion:—

Alfred Edwards, 14 years old, of New York, received on the 9th of July, 1868, while playing with his fellow-students at an educational institution in Heidelberg, a blow directly on the front of the eye. He did not experience any great pain at first, nor perceive any trouble in the eye until four days later, when he came to consult me, complaining that *his sight* was rather worse than immediately after the blow; moreover, his eye had become painful and red. I found subconjunctival injection around the cornea, the iris discolored with a greenish-yellow tint, pupil much dilated and immovable, no trace of an external lesion from the injury, movement of eyeball free, no protrusion or any abnormal external appearance, the eyelids exhibited no symptom of injury, and the brain was entirely unaffected. Sight was $\frac{1}{8}$ in the centre of F, and correspondingly diminished in the periphery. Accommodation paralyzed. The refracting media appeared turbid, so that the background of the eye was seen as through a mist; its principal details, however, could be distinguished. The optic papilla was unusually red, and the larger retinal veins thicker and more tortuous than in the other eye; the retinal tissue itself appeared swollen and diffusely opaque. No details of the choroid could be recognized, on account of the

general haziness lying over the fundus, this being, as I noticed, densest in the vicinity of the od. My opinion was that I had to deal with a case of *traumatic iridochoroiditis.* The circumcorneal injection, the dilatation of the pupil, the turbidity which existed in the vitreous without any visible hæmorrhage, the manifest hyperæmia and transudation in the retina argued undoubtedly in favor of this diagnosis. The dilatation of the pupil and paralysis of accommodation are not infrequent in irido-choroidal affections, especially when the latter tend to serous effusions into the vitreous, as in this instance seemed to be the case. My views with regard to the diagnosis were not *incorrect*, but further observation of the case proved them to be *incomplete.*

The patient was submitted to a strong anti-phlogistic treatment. Six leeches were applied to his temple, and the after-bleeding kept up for two hours, an aperient was administered, the patient confined to his bed in a dark room, and spare diet ordered. His eye at once improved. The circumcorneal redness diminished, the pupil gradually contracted and responded to light, the sight became clearer, the turbidity in the vitreous and retina and the hyperæmia of the latter also disappeared gradually. But while these changes were going on, the ophthalmoscope revealed the existence of a *curved streak*, tab. I., fig. 3, situate between the opt. d. and macula lutea, running from below upward, turning its concavity toward the o. d., and measuring ¼ D* in breadth and 2 D in length. Its edges formed irregular, but sharp lines, its color was yellow at first, but became lighter afterward and finally white. The retinal vessels passed over it unbroken. No hæmorrhage was ever visible.

But there was another remarkable change taking place during the course of this affection. Below and inside of the od., and very near its margin, the choroidal tissue became rarefied (fig. 3, after the

* D is to signify a unit in ophthalmoscopic measurement, = one diameter of the optic disc.

inverted image). Irregular whitish spots and streaks were seen in it, lying so close together and even being connected with one another in such a way as to form a semi-circular zone around the opt. d., having 1 D in breadth, and reaching from the lower end of the before-described narrow choroidal streak almost to its upper end. A small part of choroid only, just above the papilla, was unchanged. This zone of whitish spots in the choroid was dotted with black pigment, collected in irregular groups, and lying partly within the white spots and partly at their edges. The whole alteration reproduced the picture we so frequently see in atrophic choroidal processes consequent on hyperæmia and exudation, especially in the higher grades of sclero-choroiditis posterior.

Two months later, when I examined the patient for the last time, the interior of the eye had entirely cleared up, the retinal hyperæmia and transudation had disappeared, the iris and pupil were in a normal condition, the power of accommodation was restored, and the acuteness of vision had risen to two-thirds of the normal standard. The boy was able to read small print without difficulty, and there were no spots before the eye when reading, nor any obliquity of the lines or distortion of the letters perceptible. Six months later I was informed that the eye had continued in the same good state.

This absence of metamorphopsia and of scotomata, together with the restoration of sight, proved that the whole affection had run its course without having caused permanent damage to the retina. That the immediate lesion from the injury was *rupture of the choroid* I need only mention, since the crescent-shaped white streak at the temporal side of the od. is the most common feature which this disease presents. The inflammatory symptoms in the vitreous, retina, iris, and choroid itself, were secondary to the rupture of the latter. The white atrophic and the black spots at the

nasal side of the od. were undoubtedly the effect of inflammation, for they bore the very same appearance as those changes we are wont to see after choroiditis. Nevertheless, I think it probable that the choroidal tissue in this region had been seriously bruised, and even lacerated to a small extent. Perhaps some of its layers only were torn, so that the sharp edges of a complete rupture were not visible, but only the image of the white spots form an atrophy which invades the different choroidal layers successively without always destroying them all. The turbidity of the vitreous may have been caused partly by inflammatory effusion, partly by extravasation of blood into the vitreous. Although I did not see any ecchymoses in the eye, it is to be noted that they have been observed in combination with isolated rupture of the choroid in almost every degree of intensity, but generally they are inconsiderable, so that they may be overlooked or cease to be recognizable when the examination is not made soon after the injury, or, as in our case, when a perfectly clear view of the background of the eye is not obtainable.

The dilatation of the pupil and paralysis of the accommodation may have been produced by direct bruising of the ciliary nerves from the blow, or by pressure on them from the choroidal hyperæmia and exudation. Among the many interesting peculiarities of this case, the most remarkable was its *terminating in complete recovery.* Whether the active treatment was conducive to that happy result, I am not prepared to answer positively, but I feel inclined to believe it, since this is the only instance I have ob-

served of complete restitution of the retinal functions in this lesion of the choroid. In all the other cases which I have seen, the patients had neglected treatment, and asked for advice later, when I had to deal more or less with an in curable condition. In the tabular statement of the cases of isolated choroidal rupture which are on record, there are but two of complete restitution of sight. In this case I could clearly observe the grave inflammatory consequences of the blow brought about in the iris, ciliary muscle, vitreous, retina, and choroid. Wherever such inflammatory changes, from whatever cause, have occurred, we deem it our duty to institute a serious treatment, of the usefulness of which every unprejudiced ophthalmic surgeon is satisfied. Why should it be inefficient or superfluous in cases where traumatic irido-choroiditis is complicated with rupture of the choroid?

Since Prof. *V. Graefe* described, in 1854, the first two cases of choroidal rupture diagnosticated with the ophthalmoscope, every ophthalmologist must have met with a number of similar cases, if he has directed his attention to the peculiar image this lesion shows through the ophthalmoscope. This image in its typical form represents a curved white streak, more or less concentric with the circumference of the od., having ⅓ D in breadth, and 2 D to 3 D in length, lying between the opt. d. and mac. l. From this typical form there are a number of variations, the most common of which are the following: the streak is sharply curved like the elbow, one branch lying on the outer, and the other on the lower, or less frequently, on the upper side of the od.; rarely the

line of rupture runs in a horizontal direction. Not infrequently two, and even more fissures are seen, running more or less parallel with one another; sometimes they are connected by transverse or oblique fissures, and not very seldom they bifurcate at one or both of their extremities. The retina, with rare exceptions, is uninjured. The *amount of hæmorrhage* produced by these isolated choroidal ruptures seems to vary greatly. Sometimes no extravasation has been observed, even in recent cases, such as the one just described; generally it is inconsiderable, and confined to the near neighborhood of the rent, in rare instances blood enters the vitreous, and even the aqueous chamber. The trifling amount of extravasation in most cases, after rupture of the vascular tunic of the eye, is an astonishing fact, which, nevertheless, is not without analogy.

Follin, in his "Leçons sur l'Ophthalmoscope," relates that he transfixed the sclerotic, choroid, retina, and vitreous with a couching-needle, then lacerated the retina and choroid opposite to the point of puncture, and had been equally astonished to observe no ecchymosis, or only a slight one, as long as by the manipulation no fluid escaped from the interior of the eye. He thinks that the equilibrium of external and internal pressure upon the walls of the vessels prevents the flow of blood, which explanation is indeed strengthened by the observation that the hæmorrhage became considerable whenever, by escape of vitreous fluid, the tension of the eyeball, and, correspondingly with it, the extravascular pressure had decreased.

The *secondary changes* of the injured parts also display

a great variety. Sometimes there is very little irritation, sometimes a certain degree of inflammation of the internal tunics which may pass away without damaging the retina, or the dioptric apparatus as we have seen so strikingly illustrated in our former case; but these happy issues are rarer than the unfavorable ones. The visual power remains more or less weakened, and sometimes is totally destroyed. Not infrequently, the impairment of sight existing shortly after the hurt, improves for a period of some weeks or months, and afterward becomes worse than it has ever been before. These variations in its course can be satisfactorily accounted for. The weakness of sight immediately following the injury, is due to inflammatory infiltration of the retina, especially its outer layers, and to exudation into the interior structures of the eye in general, perhaps also to bruising of the retina. All these conditions may pass away without definite impairment of the retinal functions. But they may, on the other hand, cause lasting changes in the delicate elements destined for the perception and transmission of visual impressions either by a thickening and degenerative process, or by atrophy. Both have been observed in that part of the retina which lies over and near the choroidal fissure, and in consequence thereof it loses its functional power more or less. The remarkable fact mentioned above, that after a period of improvement the sight gets worse again, and remains bad, is due to the *contraction of the cicatrized tissue formed in the choroidal gap.* The retina may become fastened to it, drawn backward and united to the sclerotic. Then the former regular distri-

bution of the retinal elements resembling a mosaic work becomes disturbed; and these elements, arranged previously in the regular retinal meridians, are displaced so as to produce secondary curves in the latter. When they thereby do not lose their functional powers, objects appear crooked and distorted—*metamorphopsia;* but when the sensory elements connected with the scar are destroyed, a corresponding *defect in the visual field* is observed—*scotoma.* Another consequence of this contraction of the cicatrized tissue has been pointed out by *Saemisch*, i. e. *detachment of the retina.* The retina then becomes firmly attached to the choroidal scars which, when contracting, may stretch the retina so much as to separate it from its union with the choroid.

The occurrence of a defect in the visual field by detachment of the retina, or destruction of the sensory elements lying over the choroidal fissures is easily understood; but the preservation of perfect sight, and the non-occurrence of metamorphopsia, or deficiencies in the visual field when the ophthalmoscope discovers extensive choroidal rents, is a surprising fact. The pathology of the choroid, however, furnishes analogous conditions not infrequently. We see, after exudative choroiditis, even if the retina has been involved in the inflammation, that extensive white patches—choroidal atrophies—remain on the background of the eye, and nevertheless S and F may be perfect. Further, in examining the size of Mariotte's blind spot in the visual field of eyes affected with posterior staphyloma, we often find the extent of the dark spot in the field of vision less than it

would be if the retina lying over the white figure surrounding the opt. d. were insensible to light. From these observations we may infer that the sensory elements of the retina may retain their faculty of perception, even though their usual base, the inner choroidal layer, may have been destroyed. This assertion is further confirmed by the numerous observations that detached portions of the retina became sensitive again, when the retina recovers its normal position.

After having pointed out some of the most interesting features which this remarkable lesion presents, I wished to be able to offer some plausible *theory on the mechanism of isolated choroidal ruptures;* but I confess to be not less puzzled on this point than other observers seem to have been. Only Professor *Saemisch* tries to give an explanation. He says that at the posterior pole of the eye the choroid is, by its vessels which perforate the sclerotic, in close coherence with the latter. Any shock effecting some displacement of the inner tunics from one another, would allow a motion of the whole retina upon the choroid, except at the ora serrata, where it is intimately connected with the choroid. This latter membrane adheres, at the posterior pole and in the region of the ora serrata, where the anterior ciliary vessels perforate, more intimately to the sclerotic. A shock tending to displace the choroid from the sclerotic would, therefore, cause laceration of the former in these two regions. To strengthen this assumption *Saemisch* asserts that all the isolated choroidal ruptures were at the back of the eye, and in the one case, where both choroid

and retina had been lacerated, the lesion was near the ora serrata.

Although this sounds like a reasonable explanation, it never has satisfied me. The region of the ora serrata is not exactly at the entrance of the anterior ciliary arteries, but lies back of it. At the posterior pole of the eye, I can well imagine a shock may effect displacement or distension of the choroid, and not be sufficiently powerful to rupture the trunk of a perforating ciliary artery. The latter then acts as a fixed point, stopping the movements of the tissue on one side, while that on the other side is torn violently from it, and thus lacerated.

This partial attachment of the choroid to the sclerotic, by means of the ciliary arteries may, perhaps, *favor* in some degree the choroidal rupture, but I think the explanation will be more simple and faithful to nature, if we try to adapt it to the various facts known under the designation of "*fractures par contrecoup.*" The skull has furnished, thus far, the greatest number of observations belonging to this class. The shock or blow received, for instance, at the right side of the skull produces in one series of instances a separation of tissue at the point of injury, such are "direct or immediate fractures;" in another series the blow is conveyed or transmitted to a distant part with so much force as to overcome the resistance and elasticity of the tissue, that is, to cause the separation of its structural elements. These are "fractures or ruptures par contrecoup." The resistance and elasticity of different adjacent tunics or walls being different, we may fairly admit that those structures are

first and more extensively torn which possess the least degree of both. The analysis of the effects observed, in certain cases of such injuries, may offer the greatest difficulties, since an indefinite number of insufficiently known causes may have been at work in the production of so complicated a result. Besides the *power and direction of the forces, we have to take into account the physical qualities of the different parts acted upon.* So we find that injuries on the head, in some cases, fracture the bones at the opposite side of the skull, while in others they leave them uninjured, but cause extensive hæmorrhage of the pia mater and the brain substance, the result of laceration of those soft parts which lie opposite to the place directly hit by the blow. Such a case I saw in one of the last meetings of the New York Pathological Society. Dr. *Finnell* showed the brain of a patient who had fallen from a stoop and struck his head against the stone pavement. When taken up he was insensible, and shortly after died. At the autopsy a considerable amount of extravasation under the scalp was noticed over the right parietal bone, the seat of the fracture, and on the removal of the calvarium a large clot of blood was found, covering nearly the *whole external surface of the hemisphere of the opposite side.* (See *Medical Record*, vol. iii., p. 521.) It can not be said that the pia mater and brain substance were, physiologically, more closely adherent to the d ra mater and bony wall of the head, just in that region where the hæmorrhage was situated, nor was there any pathological adhesion observed. In the same way we see, in some cases, the choroid ruptured without laceration of the sclerotic or

retina. From this fact we may deduce no other conclusion than that the choroid proves less resistant or elastic than the two other tunics of the globe. But the choroid is by no means the only membrane of the eye that shows isolated ruptures. The zonula Zinnii and the lens capsule, and sometimes even the iris, are easily lacerated, and in various ways. Dislocation of the crystalline is not an infrequent occurrence after blows upon the eye. The anterior capsule has often been found to be lacerated, and, in one most curious case, I even observed, after a blow, an isolated and *circumscribed rupture of the posterior capsule* at the posterior pole. This case was observed in its course at my clinic; the lens substance remained for a time transparent, while the posterior cortical layers became successively opaque, and protruded through the fissure into the vitreous body in just the same manner as it penetrates into the anterior chamber after discision of the anterior capsule. Dr. *Lawson* (Injuries of the Eye, Orbit, and Eyelids, London, 1867, p. 246) relates a remarkable observation of isolated *Rupture of the Retina at the posterior pole of the eye.* A sailor had struck his eye against one of the stanchions of a ship. When Dr. *L.* saw him, ten months later, the eye had recovered from the injury, but its sight was very much impaired. In the immediate axis of vision he was blind, when looking laterally at either side he could read No. 16 of Jaeger. In the immediate neighborhood of the yellow spot there was a small rent seen in the retina, the edges of which could be distinctly made out. Behind it lay a black deposit, either the remains of a blood clot or a collection of pigment.

It is not improbable that the choroid was ruptured at the same time, and the rent hidden from view by the black deposit.

Ruptures of the sclerotic itself are very seldom recorded. As far as my experience goes, the upper anterior part near the corneal margin is the most frequent seat of this occurrence, which agrees with Mr. *Lawson's* statement. He says (*l. c.*, p. 263), "the split in the sclerotic is almost invariably near the margin of the cornea, following somewhat the direction of its curvature. The upper side is the most frequent seat of it, next comes the inner, and comparatively seldom the lower and outer side." More than one case is fully described in my journals, where the sclerotic had been lacerated, just as if a superior flap-extraction had been performed within the sclerotic, the lens having escaped through the gap, and the iris prolapsing into it. In other instances the sclerotic has been seen lacerated further backward, the crystalline thrown out through the opening, and lodged between the sclerotic and the uninjured conjunctiva in the subconjunctival tissue.

All these various cases of injuries of the eyeball have mostly been recorded, up to the present day, as ophthalmologic curiosa, and will remain so until the observations are sufficiently numerous and explicit to afford a general description, giving us full insight into the relations of cause and effect, that is, the explanation of their mechanism. The isolated choroidal ruptures form only one section of this series. Although they are not very infrequent, and are easily recognized, it is rather surprising that, since the

description of the first two cases in 1854, only fifteen others have been published, and only a single one, that of *Von Ammon* has been elucidated by a post-mortem examination. The different treatises on eye diseases make but slight mention of them. *Mauthner* gives the fullest account of them, and devotes five pages of his most valuable Treatise on Ophthalmoscopy to their description. The great practical importance of this lesion, the different interesting questions it raises with regard to its mechanism, and the analogy it bears to similar traumatic affections of the head, will certainly justify and reward a more extensive study of it.

The following case is of *special interest on account of the changes which subsequently took place in the region of the yellow spot.*

Ph. T. Westenhöfer's son, from Klingenmünster, Palatinate, had been hurt, four weeks before I saw him first, by a clod that flew on his right eye. The eye at once became painful, lids and conjunctiva swollen, and all objects appeared very dim. After two days the swelling and pain subsided, the general dimness of the visual field contracted into one dark spot lying just before the object looked at. In this condition it had remained until the patient came to me for advice. The external appearance of the eye indicated nothing abnormal except a dilated and immovable pupil. No remedy had been used. With +8 the patient could read Sn. XIV., but a dark gray round spot lay directly over the letters looked at. At the distance of a foot this spot assumed a diameter of about 15 mm. Through it the letters could be made out; none were wanting, imperfect, or distorted, and the lines, when held in a horizontal, vertical, or any other position, were in no way crooked. Tn. E.—Left eye normal.—With the ophthalmoscope I saw two curved white streaks (Tab. I., Fig. 4) between the

yellow spot and the optic papilla, turning their concavity towards the papilla, the larger outer one having 5 D in length and $\frac{1}{3}$ D in breadth, the smaller $1\frac{1}{2}$ D in length and $\frac{1}{5}$ D in breadth.

These streaks had the usual appearance of choroidal ruptures: they were white, had sharp, somewhat torn edges, black pigment scattered on their area and along their edges, the retinal vessels branching over them in the usual way. The *region of the yellow spot exhibited a finely circumscribed extravasation;* the blood a little darker at the periphery. This was the evident cause of the scotoma in the centre of the visual field. As all symptoms of irritation had passed off, I only gave the patient mercurial ointment to be rubbed into his forehead and temple. A fortnight later, when he came to me again, I found no material change in his eye. A month after that the external appearance of the eye and dilatation of the pupil were as before, the white streaks in the choroid unchanged, but the red patch at the yellow spot had become somewhat blanched, and a number of dark-black dots were irregularly scattered over its area. The patch itself had a little enlarged, the adjoining tissues were still normal. *With spectacles + 8 he now reads Sn.* $1\frac{1}{2}$ *fluently at 8 inches distance.* No power of accommodation. The scotoma still existing, but smaller and much paler. No metamorphopsia. Experiments similar to that of *Mariotte* revealed no abnormal blind spot in the excentric field of vision. Indirect sight was perfect. Five weeks later the patient presented himself again, this time with interesting changes in his eye. The scotoma in the centre of the visual field had become enlarged and much darker, so that now No. 11 Sn. only could be read by indirect vision. The dark spot in the visual field had a peculiar shape, such as represented in Fig. 4, A., which was drawn by the patient himself as seen at the distance of one foot. Straight vertical lines were interrupted, that is, not recognized in the central scotoma. *The lower ends of their upper parts were markedly bent towards the middle line,* the latter showing no

curvature. The lower parts of the vertical lines appeared straight in their whole course. When the patient looked at the centre of a piece of money, a Prussian two-thaler piece, for instance, *the upper border appeared more strongly curved, as if belonging to a smaller circle* (Fig. 4, B). Of this he could see the upper third only, whilst the two lower thirds were hidden by the scotoma. In looking, not at the centre of the piece of money, but on a point situated midway between the centre and the upper border, the two upper thirds of the coin were hidden, and the lower likewise appeared somewhat smaller than when he looked at it with the healthy eye. *This metamorphopsia and micropsia*, as I shall presently explain, had a common cause.

I examined the eye with the ophthalmoscope and found every thing in its former state, except the region of the yellow spot. The red stain—due to extravasation—was still well marked in its outline, which was studded with dots and short lines of black pigment (Fig. 4, C, erect image). The outer half of its surface was red as before, only somewhat motley, red patches intermingled with yellowish ones and black dots. The inner half was whitish, traversed by red and white streaks, and besprinkled with black dots. The retina, adjacent to this stain, was opaque, forming a bluish zone around it in a breadth of about $\frac{1}{3}$ D. This zone, as well as the white streaks on the inner half of the extravasation, were slightly raised above the level of the retina. A month later the patient came again to me, but functional and ophthalmoscopic examination revealed no change in his eye, except that the extravasated spot was less red and it showed a greater amount of black pigment.

REMARKS ON THE FOREGOING CASE.

The isolated ruptures of the choroid between yellow spot and opt. n. are usually caused by concussions. The extravasation on the mac. l., however, is unusual. It must have

been occasioned by the accident itself, and not by a subsequent choroido-retinal inflammation, because the patient noticed the corresponding scotoma immediately after the injury. As the hæmorrhage presupposes a rupture of vessels, and as the choroid is most essentially a vascular membrane, we may admit, that at the mac. lut. another smaller rupture of the choroid was caused by the injury. The most remarkable feature of the case is its course. Gradual improvement during the first two months, so that the visual power had nearly returned to its original standard. After that, however, vision became gradually worse again, and a most distinct and dark scotoma, that is a circumscribed blind spot or defect, developed itself in the centre of the visual field, where it had existed, in a less degree of intensity, during the first weeks after the injury. The surroundings of this blind central spot in the field of vision showed characteristic distortions of objects, of which I have noted and illustrated the two most striking ones. The experiment with the vertical lines (Fig. 4, A) is thus to be explained. The choroidal rent at the mac. lut. produced at first a certain degree of inflammatory action, by which a new formation of connective tissue took place in the neighborhood of the gap. By this tissue the retina and choroid were firmly glued together. Wherever a new formation of connective tissue to any considerable degree is brought about, contraction most commonly follows. This latter causes dislocation of the neighboring tissues by drawing them in that direction where the greatest amount of cicatrix has been produced. In this case the contraction of the cicatrix must have been

in a horizontal direction, and especially manifest at the lower border of the rent. The effect of this contraction might be expected to bring both sides to the centre. This, however, did not happen, but just the contrary: the retina overlying the choroidal gap was drawn in lateral directions both to the right and left side. The contraction, moreover, was pretty equal in its effect on both sides. The retina by this stretching was detached from its concave basis, being stretched over it as a chord over its arc. These anatomical conditions may, with unerring certainty, be seen by the one simple experiment with straight lines. The detachment is proven by the existence of a blind spot in the visual field, the bluish-white color, and slight elevation of that part of the spot which had been cleared from blood. That this detachment of the retina was the result of a stretching, in such a manner that a plain surface was extended over a concave one, is not only a simple result of the anatomical conditions, as *Saemisch* has set forth in the analysis of a similar case, but our observation demonstrates the correctness of this supposition by the visual proofs. The ends of the straight lines appeared bent towards the middle line. This signifies that the retinal elements lying in the retinal line *c b*, Tab. I., Fig. 4, A, were formerly so situated that they received the image of the curved line *c a* in the visual field. If we make a copy of this figure 4, A, and turn it upside down, then the latter may represent the retinal image of the former. The retinal elements, lying in the line *c b*, of a healthy eye, would, on being made the recipient of an image of a corresponding straight line without the eye, cause the sensation of this straight

line in the visual field. But suppose now the retina being so stretched at this spot, that the elements of the curved line *c a* had taken the position of *c b*, and the same straight line outside the eye having unvariably kept its former place, then its image would fall upon the retinal elements which were formerly situated in the curved line *c a*, and would, according to the law of visual directions (see pp. 190 and 191 of these archives), be so perceived as to create the notion of a curved line in the visual field. This law, that a dislocation of the sensitive elements of the retina and other nerves causes a false localization of the objects of perception, is a well-known fact. The dislocated retinal element will project impressions of light always in the same direction as it used to do before its dislocation. If a rhinoplasty has been made by transplantation of skin from the forehead, pricking the new nose will give the individual the false impression as if his forehead had been pricked.

The irregular appearance of round objects, for instance a piece of money which our patient had noticed, and illustrated in Fig. 4, B, Tab. II., is accounted for in the same way. The retinal image of the object was portrayed now on elements that formerly lay closer together. After their distension, they occasion the notion of a smaller object in the visual field, exactly of such size as would have been brought about by a retinal image covering them in their former normal position. That the traction of the retina has been equal in both lateral directions ensues from the fact that the middle vertical line, Fig. 4, A, did not appear displaced or crooked.

This analysis of our case offers a fair example of what kind of changes may take place, when a longer period of time has elapsed after the injury. It confirms the ideas of *Saemisch* with regard to the mechanical manner in which detachment of the retina may be produced. But this kind of change is by no means the only one. The cones and rods of the retina may be injured and destroyed in many ways. The injury may bruise or tear them together with the choroid; the hæmorrhage and subsequent inflammatory action may blunt or annihilate their functions; the formation of a cicàtrix in the choroidal rent may distort, compress, and unite them to the sclerotic. In the latter instance another kind of metamorphopsia would be the consequence; straight lines would be bent outward, and objects appear larger, because of the retinal elements lying then closer together than natural. The fact observed by *Saemisch* during the course of the foregoing case, viz., that soon after the hurt a considerable improvement of sight may take place, which afterwards will be lost again, is by no means the exception; but rather the rule. In all the recent cases that came under my notice I observed it, except in the one first related here. The ultimate deterioration of sight must be ascribed to the prejudicial influence of the choroidal scar on the membrane of the rods and cones in one or the other of the ways just described.

The first case of isolated choroidal rupture I have observed is that represented in Fig. 5, Tab. II.

A healthy man, Joh. Riehm II., from Käferthal, near Mannheim, was hurt, twelve days before his presentation in October, 1861, by

a piece of wood flying against his right eye. He was unconscious for some time, had dimness of sight and swollen lids. When he came to me there was ecchymosis of the lids, but no inflammation, conjunctiva and globe uninjured, iris normal, pupil responsive. He had a very dark scotoma in the centre of his visual field, but normal vision in all peripheral parts. With the ophthalmoscope I discovered a round red speck exactly in the region of the yellow spot, reaching very near to the opt. d., and measuring about 3 D in diameter. The centre of the red spot was darker than its periphery. Just beyond the centre, about 2 D distant from the opt. d., was a white vertical streak, ending in a point above, and in three notches below (the figure represents the inverted image). The length of the streak was 2 D, and its mean breadth $\frac{2}{3}$ D. Its surface was whitish-yellow, with some red lines, its edges were sharp, somewhat elevated, and in some places red from accumulation of blood. The retina was uninjured, and free from hæmorrhage. The blood was gradually absorbed, but the patient retained a central scotoma, although less extended and less intense than at his first calling on me.

This may be regarded as one of the usual forms in which isolated choroidal rupture is observed.

The following case, represented in Fig. 6, Tab. II., has some peculiarities. It came under my notice in December, 1861, a twelvemonth after the injury. This had been caused by a shot from a pistol loaded only with powder. The grains of the latter were still visible on the face and on both eyes, more abundantly on the left, where they located in the cornea and sclerotic. This left eye has suffered constantly since the injury. Repeated attacks of pain and redness set in from trifling causes. The patient was able to count fingers with this eye at 1′ distance only. A black veil was constantly masking the visual field, which itself was very much contracted.

Small black bodies and clouds were constantly floating before the eye. Tn. With the ophthalmoscope floating opacities of the vitreous were observed obscuring, to some degree, the fundus. A curved *horn*-like white streak surrounded the lower and outer side of the opt. d. (See Fig. 6, inverted image.) In the lower and outer part of the fundus of the eye remarkable changes were detected. A great many irregular white spots were manifest defects of choroidal tissue, exposing the sclerotic to view. The larger choroidal vessels were preserved, and the retinal vessels were seen to pass through this region without any marked alterations. Black pigment was deposited irregularly in and around these white spots, as is usually seen in atrophic choroiditis. In one place, however (the highest and innermost in Fig. 6), the retina was detached to a small extent, like an oval sac of bluish appearance.

The injury in this case had a double effect. It caused rupture of the choroid par contrecoup near the opt. d. in the usual form, and, beside that, choroiditis or choroido-cyclitis at the place where the powder had infringed on the sclerotic. The latter effect I have not infrequently seen, especially in the form of a very unpleasant cyclitis, producing plastic exudations, stretching from the ciliary body towards the posterior pole of the crystalline. Perhaps it would have been advisable to remove that eye, but since I did not hear of the patient again, although I was in his neighborhood for eight years, I do not think it likely that sympathetic trouble ensued.

The case represented in Fig. 7, Tab. II., is remarkable for *the extent and shape of the choroidal rupture, including three-fourths of the opt. d.* The rent had been produced by a blow without lesion of any other part of the eye. A

certain degree of choroiditis must have followed it, for there were some marked atrophied spots in the choroid.

The two following cases were remarkable for showing distinctly the formation of cicatrized tissue in the wound and its adjoining parts :—

The first, Fig. 8, was that of a woman, 33 years of age, who had received, five years before, a blow on her eye. She did not feel much inconvenience from it, but her sight had become impaired. When she came to me she could count fingers six to seven feet distant. Excentric vision good. Nothing abnormal in the external appearance of the eye. With the ophthalmoscope I discovered at the background of the eye a distinct white streak, crossing the region of the yellow spot vertically and dividing into four off-shoots, two above and two below. The edges of the streak and part of its area were covered with black pigment. The white specks between the pigment had a slightly fibrillous appearance, and were distinctly raised over the level of the surrounding retina. They were not only detached retina, but rather thickened cicatrized tissue involving the retina. The retinal vessels passed over both terminal portions of the rupture.

The next case is that of a woman who had received, twenty years ago, a blow from a stone being thrust on her eye. She knew little of the subsequent history of the disease, having always been accustomed to consider this eye as incurably blind. On examination I found only slight perception of light. Nothing abnormal in external appearance. Iris and lens normal. Media clear. At the background of the eye a large crescent-shaped white spot encircling nearly the whole opt. d. (Tab. II., Fig. 9, erect image.) The latter abnormally white. Its vessels few in number, but only a little narrowed in calibre. The white spot had sharp edges lined with black pigment, through which loops of the choroidal vessels

were visible. The latter were very marked, especially in the superior small extremity of the patch, through which they passed from side to side, and could be traced into the choroidal tissue for some distance, the pigment layer being very light. The area of the white patch was slightly mottled with grey specks, but what was most remarkable was a number of brilliant white, fibrillous bands, stretching across the area of the crescent, enveloping very distinctly some of the retinal vessels, and projecting unmistakably over the surrounding parts. Along the inner and lower margin of the crescent these fibres crossed one another in different directions, radiating for the most part towards the periphery. Just below the opt. d. the white fibres stretched and radiated like a bundle of rays of light.

This is the most extensive of all the choroidal ruptures I have ever seen. It must have caused a considerable degree of inflammation, as we may judge from the great amount of new-formed connective tissue in the area of the gap. It does not seem probable that the retina was ruptured at the same time, for its vessels still crossed the rent uninterruptedly. It is remarkable enough that they were not compressed by the bands enveloping them. The vessels themselves were distinctly seen passing through the white bands; they could not only be distinguished beneath the superficial layers of the latter, but emerged also, in some places, from them for a short distance, and again passed below them, as is represented in the superior branch of Fig. 9. By the inflammatory products the retinal elements must have intensely suffered, as the nearly total blindness of the eye demonstrates.

ON THE THEORY OF BINOCULAR VISION.

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(See Tab. V., VI., VII., Figures 1 to 16, & A. B.)

IN a recent essay on the *Horopter*, in which especially those lateral positions of the eyes were examined in which the fixation does not lie in the primary position of the plane of vision, I received an unexpected, and, as it seems to me, a highly important explanation of the manner in which we see with both eyes at once. The view to which I was forced on this subject, was not arrived at without much hesitation and distrust of the impressions of my own senses, as I had always felt the greatest respect for the theory of *Hering* and *Helmholtz*, and indeed regarded it as axiomatic. I shall begin with an analysis of this theory.

I.—THE THEORY OF HERING AND HELMHOLTZ.

Helmholtz says on the 611th page of his "Physiological Optics: We must imagine exactly between the two eyes a middle or "cyclopean eye," which is directed to the

fixation point common to both eyes, and whose movements follow the same laws as those of the real eyes. Suppose the images on the retina transported from one of the real eyes into the imaginary one in such a manner that the point of vision falls upon the point of vision, and the horizon of the retina upon the horizon of the retina. *Then the points of the retinal images will be projected outwardly in the direction of the imaginary cyclopean eye.* If we suppose, for instance, our right eye to be immovable, but allow the left to pass from the parallel to a convergent position, *i. e.*, to move towards the right, by which it will in general make a rotation around the optical axis,* then the cyclopean eye would be compelled to turn in an angle half the size towards the right, and to perform half as large a wheeling rotation. The consequence of this is, that the visual images of the right stationary eye are apparently moved and turned in the same angle. As the meaning of these sentences, especially in regard to physiological single and double vision, will not be immediately understood by every one in its full import, I shall premise a few words concerning the *horopter* and the identity of the retina, and then give a more particular explanation.

* Among the different movements of the eyeball, by which the visual line, or optical axis, is directed to any point in the field of vision, a rotation of the eye around its optical axis may at the same time take place. The German physiologists express this kind of rotation by the word *Raddrehung*—turning of a wheel—because the retina is thereby turned like a wheel around the optical axis. The word being highly expressive and needed, we have ventured to make a literal translation of it into *wheel-turning or wheel-rotation.*

The existence of double images proves that we do not see every point of the outside world, at least not with each eye, at the place where it really is. If we fix our eyes upon a point before us which shines with its own or borrowed light, then we shall see in general the other parts of our field of vision double, those of them only excepted which form an image upon the identical places of both retinæ.

In Fig. 1, m_1 and m_2 are "*corresponding*" points, because their co-ordinates are the same; that is, $p_1 m_1 = p_2 m_2$ and $q_1 m_1 = q_2 m_2$.* They become "*identical*," if there is or can be represented upon them, in any given position of the eyes, *i. e.*, in quiet fixation of any point in the field of vision, any illuminated or luminous point in space. If both eyes look straight forward towards a point of the horizon in infinite distance ("primary position of the plane of vision"), then the plane of the horizon will cut the retina in two circles, which are called the "*horizons of the retina.*" The lines $a_1 b_1$, $a_2 b_2$, represent arcs of these circles. If the point of fixation of both eyes lies at a limited distance, and not in the continuation of that plane which divides the body into right and left halves (median plane), but laterally to it, the eyes will make a rotation around their axes, which nearly correspond with the lines of vision, and consequently the retinal horizons $a_1 b_1$ and $a_2 b_2$ will form an angle. The contents of this angle are given by the formula of *Listing*.

The proposition that an objective point, which is por-

* We must here disregard, for the sake of clearness, the influence of the apparent vertical meridians.

trayed upon identical points in both retinæ, is seen singly, may be regarded as a truth sufficiently demonstrated by experiment.*

In any given position of the eyes, by which any point at a limited distance is fixed, there is always only a continued row of points in the field of vision, which are seen singly, and form together one line.† This line in space, which always passes through the fixed point, and all whose parts are seen singly, is called "*horopter.*" According to the theory of *Hering* and *Helmholtz* we do not see with each eye by itself, during any quiet position of the eyes, the lines of direction running towards different objective points, but as though there was a single eye between the two real eyes, in the region of the root of the nose—the so-called *cyclopean eye.*

By this, however, it is not intended that our seeing with two eyes is in fact only seeing with one eye, otherwise double vision would be impossible ; but this cyclopean eye is in fact to be regarded as a concentric double eye, both whose retinal concavities, superposed one upon the other, have identical points of impression only for those objective points which lie in the horopter.

In order to represent more distinctly the relations of the cyclopean eye, Fig. 2 may serve, in which F is the fixed point, c_1 c_2 are the centres of the right and left eye, and c is the centre of the cyclopean eye. The fixed point F is now seen

* Certain restrictions of this proposition do not detract from its general correctness.

† The ground horopter-plane of *Helmholtz*, which rests upon his theory of the apparent vertical meridian, is here disregarded.

by the latter in the direction of c F. The point m, which we allowed to lie outside of the plane of vision c_1 F c_2, will be portrayed on the retina of the right eye at m_1, on the retina of the left at m_2.*

If we draw the straight lines marked by the letters μ_1 c n_1 and μ_2 c n_2 relatively parallel with m_1 c_1 m and m_2 c_2 m, then the point m will, by the cyclopean eye, be seen double, namely at n_1 and n_2. By this we are enabled to get an insight into the theory of *Helmholtz* quoted above.

Hering calls the directions in which the cyclopean eye sees the objective points, singly or doubly, "*directions of vision.*"

He allows, in general, of no other vision than that by means of the imaginary cyclopean eye from the time that man has learned to distinguished the visible world from his own self. He says, in his "Contributions to Physiology," p. 166, par. 70, "If in symmetrically placed eyes the retinal fossa of one eye is irritated, then the corresponding image appears in such relations to our own body, of which we are, at the same time, conscious that the plane of a section which divides the imaginary image of our body into symmetrical halves, in its prolongation passes through the visual image of the object. Whoever calls the visual image of his body his own self, may then say he sees the objects immediately before him. But the real object which produced the retinal image need not, therefore, lie in the same relative

* We must remember that the straight lines c_1 E and c_2 F, are called lines of vision, and that the plane c_1 F c_2 is called the plane of vision.

position to our real body. If we fix both eyes upon a finger held straight before the face, it will appear in the median plane above mentioned; if then we shut the left eye, the finger remains, as before, in the median plane.

Immediately behind the finger, in the same median plane, there will appear, perhaps, a window frame, or a tree, or some other object. The corresponding real window frame, or tree, does not lie at all in the median plane of our real body, but more or less to the left side. Without regard to the real place of an object, and to the relative position which then the line of vision assumes with reference to the median plane of the real body, the visual image appears in the median plane of the imaginary body as soon as the retinal image is formed on the fovea centralis of one or both of our eyes, being in a symmetrical position.

If the image is formed laterally upon the retina, it appears to the side of the median plane of the imaginary body; if it lies above, it appears beneath, &c. By this relation of all visual images to the simultaneous imaginary image of our body in our mind, the latter image becomes the starting point of all the directions which may be conceived between it and the surrounding visual images. These directions which our imaginative faculty assumes in space, are the *directions of vision or visual directions.* For simple reasons which we can not stop to explain, it is permissible to accept for the visual directions a single point of intersection just as for the visual lines. As, however, to our organ of vision pertains not only the perception of direction, but also that of the distance of objects,

and the latter materially results from binocular vision, therefore Hering ascribes to the cyclopean eye the faculty to discriminate, quasi to feel, the distance of the visual objects, and this it does according to the retinal meridian in which the direction of vision lies.

This *sensation of space or depth* of the retina is, according to him, not the same for the images which lie in corresponding retinal meridians, but only for the images of those retinal meridians which form, with the median plane, equal angles only, preceded by inverse signs. He calls these *symmetrical meridians*. Now, if the angles of these meridians, on one side positive and on the other negative, are not equal, then the sensation of depth will correspond to the arithmetical medium of the absolute size of both angles (pp. 293–4, *l. c.*).

We believe that the ingenious author has arrived at this theory only by too general and exclusive an application of the cyclopean eye to the act of vision.

II.—The Prevailing Eye.

In venturing now to explain the view which has been more forced upon us than sought for, we will begin with some observations on *vision in taking aim* (Visiren).

In taking aim, we try to determine, as near as possible, the *direction* in which a luminous point is seen, without regard to its distance. Everybody will grant that in this process only one eye is used, even if we keep the other one open at the same time, and direct it on the object aimed at. In the first place, the other eye is not necessary, as we have

no regard to the distance of the point which is aimed at; and, besides, it is only possible to aim accurately in the visual line of one eye. Let us try the following experiment. Desire a perfectly unprejudiced person who sees clearly with both eyes, and who is right-handed, to hold his finger perpendicularly and raise it from beneath upward until it comes in front of any given point on which he gazes with both eyes, that is to hold the finger so that the object seems to be behind the middle line of it. He will always place his finger in the visual line of the right eye, so that, by closing the left, the point of fixation will be completely covered by the finger.

If, on the contrary, he is requested to bring the finger to the point of fixation by moving it from left to right, he will stop when the finger comes into the visual line of the left eye, and, consequently, he will have effected the adjustment for the left eye.

The same result will be obtained if the finger is held horizontally, from before backward, instead of vertically. If, on the contrary, we request that the left index finger, being held horizontally, be moved from below upward into the visual line of the left eye, this will, in most instances, not be arrived at, but the finger will be so moved that its end will lie in the visual line of the right eye. When I try this experiment myself, it does not generally succeed; if I accommodate for the finger, and if I want to be sure of the result, I must first call to mind the double images of the finger, and adjust the right image to the left eye.

Most people, therefore, in taking aim, do not voluntarily

use either one eye or the other, but allow the stronger, generally the right, to prevail over the other. I think we may assume that this peculiarity, as it has a certain analogy with the prevalent use of one hand, stands also in casual connection with it. From childhood up we are trained to use principally the right hand in all our actions; hence arises the prevailing use of the right hand. As we naturally use this hand by preference in all those actions which demand sharp sight, or prolonged aiming in childhood, in touching, striking, throwing, &c., in riper years in shooting, fencing, hewing, &c., we come also to use the corresponding eye in a prevailing manner; for we are unable to execute such accurate motions with the right hand if we look or aim with the left eye and close the right.* Nor can we do this with the cyclopean eye of Hering, that is, if we use both eyes in the same manner and at the same time. (Indistinctly conscious of this, most sharp-shooters believe that they can not shoot accurately with both eyes open.) By all this, according to my opinion, the prevailing use of one eye, generally the right, is satisfactorily explained.

The contrary proposition, that one who is left-handed also uses principally the left eye, is not to be admitted without circumspection. A man whom I know, though he is left-

* If, for instance, we place a finger of the right hand in the visual line of the right eye, and then shut that eye and attempt to move the finger rapidly towards the point of fixation, the finger instead of having approached the point of fixation directly, in following the visual line of the right eye, will have deviated considerably to the left. But if we keep the right eye open, we can move the finger forward as far as our arm can reach in the visual line of the right eye, though we likewise see the fixation point with the left eye alone.

handed for most purposes, is obliged in many actions which demand aiming in the visual act, for want of corresponding tools, to use the right hand and the right eye (he is a cooper, and is obliged to use an adze made for the right hand for hewing the staves, he is also a sharp-shooter, and has a rifle stocked for the right hand). With him the right eye is the prevailing one. For this investigation, those individuals are best adapted in whom the right hand is wanting or crippled from birth. One such case happened to come to my knowledge, and was quite in favor of my hypothesis. In this person, of whom I speak, who had a crippled right hand with only an atrophied thumb and forefinger, but no other defect, the left eye was the prevailing one to such a degree, that he thought he could do nothing with the right eye alone, although nothing abnormal was discovered in it, and he himself was not aware of any dimness or confusion of images.

Although I am of opinion that every man possesses a prevailing eye, I will by no means deny that with many, by exercise, for instance, in taking aim, in looking through the microscope and telescope, the other eye may become as available as the predominant one. The latter, however, retains nevertheless its once acquired superiority, as can easily be proved by an experiment referred to in the following section.

III.—The Mode of Binocular Vision.

To what has been said in the previous section, with regard to taking aim in seeing, must be added the following: If we place a straight wire *a b* in the line of vision of the right eye O_1 (Tab. V., Fig. 3), while the open left eye O_2 is likewise directed to the point of fixation, then must, according to the theory of the visual lines, the right eye, transferred to the imaginary cyclopean eye, see the wire *a b* in the direction of M F, but the left eye in $a_1 b_1$. Now, the first conclusion manifestly is not confirmed by the experiment,* but we see the wire *a b* with the right eye O_1 in its own visual line. (The position of the double image of *ab*, which is seen by the left eye, we shall leave unnoticed, as being here of no particular interest.) One might say this was an exceptional case, the points *a b* lying too near the right eye to allow both eyes to act uniformly. While we grant this for the present, we assert the following proposition: *If we bring a point* a *pretty near the eye* O *in its line of vision, while both eyes are directed to the point* F, *then the eye* O *sees the point* a *in the line of vision* O F *and not in the direction* M F.

Suppose a somewhat distant point, F (Fig. 4), which we fix, is straight before us in the median line M F, and another

* Even in the experiment of *Helmholtz* (Phys. Op., 612, 613), where a finger, being hidden behind a shade, is moved from below upward into the line of vision of one eye, it is asserted that it comes into view correctly if the situation of the right fixing eye is distinctly remembered. I come, when the right eye is looking, with my finger nearly always into its line of vision; on the contrary, if I look with the left eye, the finger usually appears far to the right.

point a (say a pin's head) be in the same line, also straight before us, tolerably near. If we look alternately with one eye only open, towards a, we shall see with the eye O_1 the point a in the direction $O_1 r$ so far from F towards the left as it is with the eye O_2 towards the right in the direction $O_2 S$.

If now we fix the point F, we shall see a double image of a. In order to determine the position of this double image, we bring a second point b before or behind a, in such a manner between the double images, that its double image which is seen by the right eye lies exactly in the middle between the double images of a. If now we shut the left eye, we see the point b exactly in the visual line of the right eye.

As now, according to the previous proposition, b really lies in this line of vision, and is besides found exactly between both double images of a, it follows, *that both double images lie symmetrically on both sides of the visual line of the right eye in* a, *and not so in regard to the median line* M F. If we continue to move b by unchanged fixation on F so far towards the left that its double image, which is seen by the left eye, falls exactly between both double images of a, and then close the right eye, we shall find that now b lies in the visual line of the left eye, about in the position of B, *so that we*, if we have held our first impression of the double images a a unchanged, *see the double image of* b *in the visual line of the right eye, although it lies in the visual line of the left* (*in* B), and is seen with the latter at the very same place b, where we before beheld the image seen with the right eye. The double image of b formed by the right eye

will be seen in its true position at B. If, on the contrary, we first bring the double image of *b*, formed by the left eye, exactly between the two double images of *a*, maintain the impression we receive of the position of these double images, and continue *b* so far towards the right that its double image seen by the right eye falls exactly between those double images, we shall easily convince ourselves *that we see the double image which belongs to the right eye (really lying in the visual line of the same) in the visual line of the left eye*, while the double image of the latter lies in its true position.

We conclude from this, that, in the act of seeing, we involuntarily or voluntarily permit one eye to prevail or dominate, and visible objects are seen with this eye in their true places, while they are seen with the other eye in such a way as if the latter were, together with the impressions its retina had received in its true position, transferred upon the prevailing or dominating eye, just as above, according to Helmholtz, both retinæ were transferred to the imaginary cyclopean eye.*

The relation here is obviously more simple, as only the one eye is supposed to be transferred upon the other, which remains unchanged in all respects. All points which do not lie in the horopter are accordingly also seen double. But

* The idea of prevalence is absolute, since according to my view, as has been said above, every man has an absolutely prevailing eye, although not in the same degree as is the case with the prevailing arm, because the muscles of the eyes can not be used on one side more than on the other; the idea of domination, on the contrary, is relative, as it lies in our power for a special purpose to subordinate one eye to the other.

the impressions of the weaker eye are suppressed in ordinary vision by the stronger one, and only those parts of the field of vision which from their position make an impression on the weaker eye alone, are really seen by it, and thus the visual field of the prevailing eye is completed in such a manner that we imagine we see by the prevailing eye all that we see only by the weaker eye, although we are completely conscious of the co-operation of the other eye. The deductions from the above experiments are confirmed by the following. For these experiments it is best to use the apparatus represented in Tab. VI.

This consists principally of a movable box C, which has placed upon it at right angles and in an oblique direction a frame destined to carry the board T, upon which the two lines to be observed are drawn, and which is fastened to a head A by a tenon B, in such a manner that to its upper surface C, any desirable elevation or depression may be given by means of the screws R and S. The little frame bears a movable arm E, which is furnished with a joint N, whose other piece V is made of cork, and has a needle F upon it for adjusting the eyes, when beholding the lines upon the plate T principally with crossed visual lines. If we place the surface C of the movable box horizontally (by means of a tube-libella) and put into the frame T a band upon which are drawn two perpendicular straight lines *a b*, as in Fig. 5, in such a manner that their centres are at the same level as the eyes, while we rest the chin upon the head A of the apparatus, or take the little board H between our teeth, and fix the point *a* with the right eye, and the

point *b* with the left, then both straight lines will coincide with one which lies (come together) *in the line of vision of the right eye.** *The separate image of* a, *corresponding to the right eye, will be seen in its true place, that of* b, *corresponding to the left eye, on to the right of* a. In order to behold the same straight lines (Fig. 6, where they are marked with reversed letters) with crossed lines of vision, we give to the needle F, of the apparatus (Tab. VI.), such a position that the visual line of the right eye which passes through its head, strikes the point *a*, and the line of vision of the left eye the point *b*. If now we fix the head of the needle in such a manner that it is seen singly, we see then, coinciding with the needle and, as it were, prolonged from it, the united image of both lines *a b* in such a manner that it lies in the air at a distance from the board, while the separate images of these straight lines which are formed because the right receives also an image of *b*, and the left one of *a*, lie nearly in the level of the board, so, however, that that to the right of the united image lies somewhat more forward and to the right than the left separate image, which is more backward and to the left. We shall now consider further two systems, of two curves each, of which one is to be observed with direct and the other with crossed lines of vision, in order to obtain the corresponding horopter, by lines of direction projected into space. For the sake of

* If we look at two lines, straight or curved, which, by a proper position of the eyes, represent themselves upon identical parts of the retina, and which consequently by their outward projection unite in the horopter, we see three images, of which the middle one is the united or stereoscopic image, but the other two belong each to one eye, these latter I call the "*separate*" images.

explanation we will use Fig. 7, while the corresponding systems are represented in their true form in Pl. 2, and which may serve for observation if they are drawn on a window upon tissue paper and then transferred to a glass plate. The position of the eyes appropriate to system A (Pl. 2), may be determined in the following manner:—

If we imagine a line *a* drawn from the root *n* of the nose of the observer, and through Z (Fig. 7), and permit the board T, that is the plane of the curve, to stand normally upon the straight line *n z*, then the length of *n z* is 128.5 millimetres, the inclination of *n z* towards the horizon 20°, and the deviation of *n z* from the median plane towards the right 18°. By means of the apparatus (Pl. 1), it is easy to effect this position of the eyes. Place the little frame upon the hind pin V, of the box *e*, and give to this the necessary inclination of 20° below the horizon, then turn, elevate, or depress the little board II by means of the loosely adjusted rod T, in such a manner that it may be taken between the teeth, the face make an inclination of 18° to the right, and the eyes be in the same level with the line *a b* on the board T.* When you have taken the right position of the head, then fix the points *a* and *b* with direct or uncrossed lines of vision. In this way both curves will unite themselves to form the horopter, which *coincides with the curved line* a *upon the board.* Of the two separate

* It is necessary to give to the head a somewhat oblique position, to such a degree that we see the straight line *a b* singly. In order to effect this without being obliged to let go the little board which is held by the teeth, the rod I must have, immediately below the little board, a joint movable from side to side.

images, the left one which is seen with the right eye is in its true position, the right one seen with the left eye, somewhat farther to the right and a little in front of the surface of the board. If we turn the little frame D of the apparatus (Pl. VI.) around so that the arm E is directed backward, and make holes in the points *a* and *b* on the board, then we may place the needle in such a way that the two lines of vision passing through the holes intersect at its head. If we now fix the latter in such a way that both it and the holes in the board are seen singly, then the horopter recedes to the needle and appears firmly united with it, whilst the separate images remain close to the board, that of the curved line *b* in its true position, but that proceeding from *a* of the left eye removed towards the right.

The position of the eyes with crossed visual lines belonging to system B, Pl. VII., is determined as follows:* The distance *n z* is 308.5 mm, the inclination of *n z* towards the horizon 10°, and the deviation of *n z* from the median plane towards the right is 21¼°. By means of the apparatus (Pl. VI.), it is again easy to obtain the required position of the head. The little frame D is here, as represented in the drawing, placed upon one of the anterior (not visible) pins of box *c*. In order to give to the eyes the suitable direction, we again bring the head of the needle to the required position between the board and the face. If we now fix the head of the needle in such a way that it appears singly, we

* In my treatise on the horopter, and the identity of the retina, I have given the elements of 130 positions of the eye, and have constructed the corresponding curves.

shall see the combined image of the horopter in its oblique direction pass through the head of the needle, and of both the separate images which lie in the surface of the board; that which belongs to the right eye will be in its true position, the left, on the contrary, somewhat nearer to the combined image and farther back. If the curved lines are drawn on a plate of glass, and we turn the latter around its horizontal mid-line, and place the apparatus in such a manner that the light passes through the glass before it reaches the eyes, leaving it in other respects unchanged, only giving the straight line *n z* a lateral deviation of 27¼° to the left, then we shall see the horopter again as a united image, intersecting the needle at a great distance in front of the plate, whilst the separate images lying close to the surface of the plate have opposite relations to what they had before, viz.: the right nearer to the right side but more backward, the left somewhat nearer to the left and rather forward. In both cases the separate image belonging to the right eye is on the right side, that belonging to the left on the left. The explanation of these phenomena is easy.

1st. By the union of the two straight lines with direct lines of vision, the image of *b*, Fig. 8, belonging to the left eye and lying in its line of vision, is transferred to the line of vision of the right eye, consequently the united image at *a* is seen opposite the right eye. The separate image of the right eye proceeding from *b* remains at *b*, but that of the left eye proceeding from *a* is, on the contrary, moved to a^1 into the angle $a\ o_1\ a^1 = \ < b\ o_1\ a$.

2d. By the union of the two straight lines with crossed

lines of vision the united image is seen at f (Fig. 9). The separate image from b of the right eye remains at b, the separate image from a of the left eye o_2 is seen at a^1, so that $< a^1\, o_1\, a = < b\, o_1 a$.

3d. The union of the horopter curves with the direct lines of vision (Figs. 10 and 11), as well as with crossed lines of vision (Figs. 11 and 12), is analogous as before; only that by the lateral deviations to the right (Figs. 10 and 12), angle V. $> w$, and with the lateral deviation to the left (Figs. 11 and 13), angle V. $< w$, from which it follows that the image to be seen by the right eye in its true position, lies farther from the united image at a than the separate image seen by the left eye at a'.

Experimenting with crossed lines of vision, one might, perhaps, become doubtful whether the united image lying near the face really appears in the line of vision of the right eye, and the right separate image in its true position, or whether, perhaps, it is not apparently seen by the cyclopean eye. But it is easy, however, to convince ourselves of the contrary, for in the latter case one would see both separate images, a^1 b^1 (Fig. 14), at equal distances symmetrically from the united image at f. This, however, is by no means the case, but we see the images at $b\, f\, a^1$ (Fig. 9), where they appear to the right eye o_1, the image a^1 lying farther to the left. I have yet to mention the following experiments which seem to me to confirm the theory of binocular vision above stated.

1st. If we unite stereoscopic images with parallel lines of vision (of course without a stereoscopic apparatus), then

the common stereoscopic image appears exactly opposite to the right eye,* where the right photographic image really lies, and the left separate image opposite to our left eye, where the left photographic image really lies, but the right separate one in the air lying so far from the right line of vision towards the right as the left towards the left.

If we, on the contrary, unite with crossed lines of vision, by adjusting the head of the needle of our apparatus, the little frame of which bears the stereoscopic image, so that the intersecting lines of vision will fall upon the identical places of the images, and fix the needle head carefully so that we only see it singly, then the stereoscopic image appears in similar relations, as the lines observed before with crossed lines of vision, but at the same time much diminished in size, probably for the reason that we believe the object to be nearer to us than it really is.

2d. If we fix with both eyes a red wafer, fastened on a dark background, and situated in the prolongation of our median plane, then we shall see its after image by plain parallel lines of vision opposite the right (or prevailing) eye.

3d. If we place two red wafers about two inches apart

* If we now, after the stereoscopic union of both images with parallel lines of vision has been accomplished, continue the same so far to the left, that the common image lies opposite the left eye, then the *middle of the common image always unites with the middle of the right photographic image*, and the left separate image with the left photographic image, while the *right separate image always lies to our right.* We here suppose that the right eye is the prevalent one. By this and the preceding experiments, one may easily be convinced that even those who think their eyes of equal strength, possess a prevailing eye. Indeed, no one can see the side image lying in the air anywhere but on the side of the prevailing eye.

upon black paper, and unite them with nearly parallel lines of vision, and then gaze with parallel lines of vision upon a sheet of white paper, held in readiness, we see the blue-green united after-image opposite to our right eye, and on both sides at equal distances, the after-images of the separate images formed upon the retina of each eye. To the above-described explanation of the act of binocular vision, is to be added that we have learned from childhood up to overlook the double image corresponding to one eye. The circumstances under which this oversight is most difficult or most easy, with fine objects lying close to the median plane, is not uninteresting. If f (Fig. 15) is a point at which the lines of vision of both eyes o_1 and o_2 intersect each other, and m, the place of a pin held out perpendicularly beyond our near point, we shall see a double image of m, *and both images are equally distinct if we accommodate for* f, *but the one corresponding to the weaker eye will be seen the least distinctly, if we, without changing the position of the eyes, accommodate for* m. The following experiment, also, corresponds with this. If we draw at the point a b (Fig. 16) two curved lines as marks, and mid-way between them a straight line, c, and then unite a and b with direct lines of vision, we see the line c and its double image c^1 with equal distinctness, while accommodating for the distance (*i. e.*, by relaxed accommodation), c, on the contrary, grows faint as well as the right separate image of the mark a^1, when we accommodate for the plane of the image, and c then appears the more distinctly. It is almost to be expected that these experiments will not give equally dis-

tinct results with all. I thought best, however, not to withhold those observations made on myself.

Finally I have to consider another phase of vision, as if it were a higher degree of the same, and in this I believe is to be found the justification of the cyclopean eye of Hering. If we consider the field of vision lying before us with quiet fixation, for a protracted period, and at the same time take into consideration the relative position of objects to our own self, we at once, without knowing it, use the left or weaker eye too as the dominating one, and survey the field of vision as it were from two stand-points. While thus alternately operating with both eyes, the idea of our field of vision is created in us, under the influence of many years' practice, as though we were seeing by means of the imaginary cyclopean eye situated at the root of the nose. This sensation is, however, according to my view, not immediate vision, but a psychical act, resulting from abstraction and reflection, receiving according to individual disposition, a more or less perfect development. The transferring of the image from the weaker to the prevailing eye, is, without doubt, a psychical act, but one which has become second nature to us, and which requires no reflection whatever, but bears the imprint of instinct.

CONTRIBUTIONS TO THE PATHOLOGY OF BURNS OF THE CORNEA FROM LIME.

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Translated from the German by Dr. Joseph Aub.

(See Plate III., Figs. 1–4, and Plate IV., Figs. 5, 6.)

Up to the present day the statements of the pathological changes which the cornea and the other portions of the eye undergo after a burning with lime are very scarce. This seems the more remarkable since the importance of this injury, and the difficulties accompanying the successful treatment of the same, stands in inverse proportion to the possibility of making experimental studies on it. We hope that the experiments and the pathologico-anatomical researches will enable us also here to find a way to diminish the dangers attending this affection, or even, under favorable circumstances, to remove it entirely.

We can, at least, with some degree of certainty, expect that the experiments will give us some results as to the

anatomical changes caused by the influence of the lime in the tissue.

Before I commence with the results of the experiments made by me, permit me to give you a short historical review of that which has been done in this field, and then I will explain the clinical as well as the pathologico-anatomical part of my work, and will close with a few remarks on the therapeutics of this affection.

All authors whose testimony I have been able to collect agree in this point, that the burnings with lime belong to the most dangerous affections, and should be placed in the same category with the cauterizations with the mineral acids, but are distinguished from them by the opacity which remains behind.

I will confine myself to the citation of those authors alone who mention something new on the subject.

Rosas* makes the following remarks on this subject: "Unslaked lime, especially when it is slakened on the eye itself by the careless and rapid use of water, is often so destructive that the cornea is totally dissolved and changed into a greyish-colored mixture, which can be washed with a small pencil from the iris. Generally, however, such a positive decomposition of the cornea occurs only in single portions of this membrane, and often only superficially. However, you can always prognosticate a white, shining cicatrix where you find a depression in the cornea immediately after

* Handbuch der therapeutischen und praktischen Augenheilkunde, Bd. II. Wien. 1830, pag. 642.

the burning. Slaked lime only produces a superficial cauterization, or causes a coagulation of the lymph circulating between the lamellæ of the cornea."

Chelius* mentions the subject thus: "Escharotics which work chemically on the eye change the habitus of the corneal tissue, and by the coagulation of the same give the cornea a white and opaque appearance, as if it were covered with a white membrane; for instance, in cases of burning with lime. Mineral acids and their vapors have the same effect."

Arlt† makes the observation that the burning with lime produces a severe inflammation, that the same is followed by an opaque cicatrix, and that the deeper ulcerations can be accompanied by iritis, hypopium, &c., &c.

Ruete‡ compares the cauterizing power of the lime with the other chemical substances, as sulphuric acid, &c., and believes that the cornea and sclerotica offer so much resistance to the lime that it is very seldom that either of these membranes is perforated. His opinion of the resisting power of these membranes he bases especially on the following case, described by himself: "I found in the eye of a mason a piece of lime as large as a pea, which had fallen into the eye the day before. It had eaten its way through the conjunctiva up to the sclerotica; the whole conjunctiva was inflamed in a high degree, but the sclerotica in the spot where the lime lay was perfectly white and healthy."

* Augenheilkunde. Bd. II., pag. 520, § 630. Stuttgart, 1839.

† Die Krankheiten des Auges, Bd. II., 3. Abdruck, pag. 207. Prag., 1855.

‡ Lehrbuch der Ophthalmologie. Bd. II., pag. 354. Braunschweig, 1855.

V. Graefe* gives a very precise clinical picture of this affection of the eye, and believes that the white opacity of the cornea is kept up in a directly chemical manner. I shall very often refer in this article to the opinions expressed in V. Graefe's paper.

In describing symblepharon (anterius) nearly all authors mention the burning of the eye with lime as one of its most frequent causes; but since my experiments were almost exclusively confined to the cornea, I can only in a few words mention the changes in the conjunctiva, and especially in the limbus conjunctivæ.

In the commencement of my experiments I deposited a little lime either in the upper or lower conjunctival pouch of a rabbit; however, I soon changed my manner of proceeding, in order to be able to study more minutely the pathologico-anatomical changes. I had a small speculum made in order to open the eyelids as far as possible, and then cauterized the cornea by means of a glass tube of moderate size which was filled with quicklime. Thus I could regulate the working of the cautery, either making it stronger or stopping its further destructive powers by allowing it to remain, or removing it immediately after the cauterization.

The rabbit appeared to me, at first, to be best suited for my experiments; but I soon convinced myself that the dog had the same advantages as the rabbit.

After cauterization of frogs' eyes I could not find this

* Arch. f. Ophth. Bd. II., Abth. I., pag. 235.

deep, opaque coloring, but only a greyish, cloudy opacity, with loss of epithelium, which regenerated very slowly.

CLINICAL PART.

It is a well-known fact that the symptoms vary greatly according to the condition of the lime, *i. e.*, whether it is dry or somewhat damp, and according to the period that it has its influence on the cornea. If you apply unslaked lime to the cornea of a rabbit in the manner above described, and then dampen it, you will notice that the cornea will be dry in a few seconds; furthermore, that the pupil will be strongly contracted even there where it had been dilated by atropia, and that the animal attempts with the secondary lid to remove the foreign body. Should you remove the lime in the course of ten or fifteen minutes, and with it the epithelium by means of some water or oil, you will observe a milky-white circumscribed opacity, whose surface, observed with the naked eye, appears smooth and shining, but if examined with a magnifying glass, is rough and uneven.

The conjunctiva bulbi et palpebrarum becomes swollen, and the subconjunctival vessels, especially in the vicinity of the superior rectus, begin to be injected.

On the following day you notice some secretion, and the white spot is surrounded by a cloudy opacity, which gradually disappears towards the periphery. On the third day the subconjunctival injection is increased, and the entire cornea cloudy. About this time the boundary line of that

portion which was robbed of its epithelium is lost, and the previously shining opacity has a totally dull white appearance.

After three or four days the spot commences to suppurate, and you can remove from the same small portions in shreds. The periphery of the cornea gradually clears up as the injection of the vessels recedes.

The opacity observed around the cauterized spot remains, and may even appear more intense ; the cauterized portion itself seems somewhat clearer and bluish-white ; at the same time the epithelium commences to regenerate itself from the periphery, and thus the spot becomes shining and of the same height as the surrounding parts. This generally lasts from fifteen to twenty days. This definite opacity is not so extensive as in the commencement, and is more intensely white.

At this time this spot is perfectly sensitive. I have had the opportunity to observe these opacities for months, and could remark that no more changes took place after the fortieth day, and the opacity was always of such a kind as described by all authors.

The process does not take this comparatively favorable course if the remains of the epithelial layer of the cornea are not removed with the lime in the beginning, or if the conjunctiva and the cornea are cauterized at the same moment. In the first case, the thing is not so simple ; on the contrary, the opacity appears much duller and more dense, and the surface is rough, but as unsensitive as formerly. As soon, therefore, as the inflammatory process has

reached its maximum, an ulcer with chalky white foundation makes its appearance, sharply defined from the surrounding opacity. The ulcer advances slowly, with occasional exacerbations of the inflammatory process, indicated by the increased subconjunctival injection. The cloudy neighborhood is also extended, and more dense, and sometimes abscesses are found in it. After five or ten days we have the same picture presenting itself to us as that which V. Graefe has described, as follows: "Finally, when only one fine layer remains, the cornea receives that traitorous transparent appearance so often seen in diphtheria; the iris appears as if viewed through a bubble of absolute transparency."*

If no perforation ensues, the cicatrization commences slowly, and in such a manner, as is evident from my microscopical observations, that the milky white spot is covered by the cicatricial tissue.

The consequences of a burning with lime appear so much worse when the conjunctiva takes an active part in the process, and especially V. Graefe attaches great importance to this circumstance. The cauterized spot assumes in this case a whitish yellow color, and the vascular portion, as for instance the limbus conjunctivæ, appears of a yellowish green color, so that these differ greatly, as regards their color, from the white opacity of the cornea.

If the lime is not soon removed, the cauterized portion will soon be covered by the swollen conjunctiva; besides

* Loc. cit., pag. 236.

this, the cauterized portion of the conjunctiva is also contracted, and lies so firmly adherent to the sclerotica that it can not be moved on the eyeball. The inflammatory process is very vehement, and combined with considerable secretion from the conjunctiva.

The cauterized portions have, almost from the commencement, a whitish color mixed with small ecchymoses. After 8 to 14 days, according to the duration of the cauterization and the vascularity of the cauterized spot, the same begins to be cast off in scales, and a large amount of granular tissue is developed, which, from its aptness to join the palpebral conjunctiva causes the conditions known long since as symblepharon, &c., &c. In this stage I noticed that a vascular net was formed on the cornea which anastomosed with more or less strongly injected conjunctival vessels.

At the same time the cauterized portion of the cornea began to cast itself off in shreds, which almost invariably led to perforation and prolapsus of the iris, purulent infiltration of the neighboring portions of the same, iritis, hypopium, &c. Then the newly formed superficial vessels disappear gradually, and in their place finer but more deeply situated vessels appear.

About this time you can also observe folds of the conjunctiva stretching towards the cauterized portion of the cornea (false pterygium). They often connect themselves with this, and then they form a true pterygium. The cicatrization meanwhile takes its common course, and we finally have all those unhappy results of symblepharon anticus, entropion, permanent opacity of the cornea, &c.

It is well known that slaked lime also causes a cauterization which is only distinguished from that produced by unslaked lime by its much more diminished intensity; I have, in order to note the difference, several times used the common builder's cement, and convinced myself that it only needs a longer influence to produce the same result.

I have had the opportunity to observe, during the winter session of 1868-69 in the clinic in Heidelberg, two cases of burning of the eye with lime. The one was of old standing, and came for relief from a consecutive symblepharon and an almost total diffused opacity of the cornea of the left eye.

The other case, which came to the clinic the day following the accident, resulted favorably. The patient was a mason, and said that he had immediately removed the slaked lime from the eye by means of an acid solution (?). On the conjunctiva palpebræ superioris we observed a cherry-sized scab of a whitish yellow appearance, with some small ecchymoses. The lower portion of the cornea was also affected to a similar extent, deprived of its epithelium, and the surface diffusely opaque. With the aid of atropia and pressure bandage the epithelium was soon restored, and the patient was dismissed after four days with but a small opacity on the injured spot. About this time the superficial scab of the conjunctiva had been cast off, and showed a good granulating surface.

MICROSCOPICAL PART.

The pictures which presented themselves to me in my researches were very different, influenced by the seat of cauterization, *i. e.*, whether the conjunctiva or cornea was cauterized; further, by the duration of the cauterizing effect of the lime, and finally, by the period in which the cauterized portion was examined.

A large number of the eyes were hardened in alcohol. In the beginning I confined myself to this means of hardening, and avoided acids of a dissolving effect on the parts which might contain lime; later, however, I also used other methods, which I will hereafter mention.

After one or two days' preservation in alcohol, the cornea has such a consistency as to allow of the finest microscopical cuts, especially if embedded in parafine.

The examination of corneæ immediately after cauterization, shows the following: The epithelium is totally destroyed on the cauterized spot, and where it has not been removed, we find it replaced by a more or less coarsely grained mass (Plate III., Fig. 1, *a*), mixed with very many comparatively large particles of lime.

After removing the epithelium we find the cornea, at the cauterized spot, shining white, and thinner than the sound tissue. On very fine perpendicular cuts of this membrane, you can see with a small magnifying power, that the opacity, whose depth is dependent on the duration of the influence, and which can therefore embrace the whole thickness of the cornea with the Descemetii and the epithe-

lium is more or less uniform, and by transmitted light appears brown or blackish, whilst by incident light it appears of a perfectly snow-white color. If we use greater magnifying powers, we observe that the spaces occupied by the corneal corpuscles are smaller than in the sound cornea and appear contracted; further, that the opacity is caused by a dusty-like substance whose grains are unusually fine and numerous, and are therefore difficult to be seen even with still greater magnifying powers. If we apply acids, for instance muriatic or acetic acid, we observe that this substance disappears with the evolution of more or less gas, and thus the cornea again becomes clear. In using sulphuric acid the opacity also disappears in the same manner, and numerous needle-shaped crystals are formed which collect in star-shaped groups (gypsum, *i. e.*, sulphate of lime).

Whilst the corneal layers swell on the use of acids and become transparent, the corneal corpuscles become more distinct and have the appearance of being clouded by granules.

What has just been described, has also been confirmed on microscopical sections made parallel to the surface of the cornea, with this single difference, that we could observe more distinctly the corneal corpuscles and their nuclei; the latter offering nothing abnormal.

Since it was often observed that the cornea was affected in its entire thickness, it was natural to examine the aqueous humor for its amount of lime.

In order to obtain the latter pure, I used a lance knife

invented by Ed. Jäger for this purpose, one surface of which had an aperture communicating by means of a metallic tube with a glass cylinder. I almost always waited some length of time (12–14 hours) after the cauterization, then I punctured a portion of the cornea which was still healthy with the lance, and pushed the latter forward until the opening was in the anterior chamber. Then the contents flowed through the opening into the glass cylinder, perfectly clear, and when exposed to the air, partially coagulated. At this period, the aqueous humor shows under the microscope a variable number of pus corpuscles, which for some length of time allow the changes in their form and locality to be easily recognized.

When sulphuric acid was added, many crystals of sulphate of lime were precipitated. The lime is generally found after coagulation to predominate in the coagulated fibrine, and is therefore peculiarly well adapted for this test. In other cases the loss of clearness and the formation of coagula in the aqueous humor, occurs before the latter is drawn off from the anterior chamber. The pus corpuscles had nothing abnormal, and the use of sulphuric acid occasioned in the beginning only a destruction of the protoplasma, so that, after its influence, the nuclei were, for a period, completely isolated and intact. The examination of the cornea, from one to two days after cauterization, differs only in the presence of a larger or smaller number of round cells, with one or more nuclei, in the periphery of the cornea and around the opacity. Especially in the periphery of the cornea they are arranged in rows between the corneal

lamellæ; later, we find them, varying in number, at the cauterized spot. In order to recognize the arrangement of these cells, I first used carmine, but because the protoplasma of the corneal corpuscles could not be plainly seen in this manner, I employed the method described by Cohnheim in his reformatory paper on Inflammation and Suppuration.*

Before, however, I had decided on this method, I had with much confidence tried the method lately recommended by Leber.†

Having had the best results from it on the healthy cornea, I was greatly astonished to find that in this case it was perfectly useless, as well immediately after cauterization, as during the period of cicatrization. The cauterized spot does not become impregnated, and the beautiful negative pictures of the corneal corpuscles appear only in the sound portion.

Then I tried Cohnheim's method, and succeeded admirably, the preparations were excellent, the fixed corneal corpuscles could be distinguished from the wandering, and the finest branches of the nerves were visible. This method has but one objection, and that is, that we must use an acid, although only in a highly diluted condition; but since I had already convinced myself of the presence of lime in the cauterized spot, it did not matter much whether the lime was dissolved, &c., &c.

A preparation treated according to Cohnheim immediately

* Virchow Arch., Bd. 40, page 1.

† Arch. f. Ophth., Bd. 14, Abth. III., page 307.

after cauterization, shows a diffuse blackish color, after metallic reduction at the place of cauterization ; the corneal corpuscles are very small and appear contracted, especially if compared with those lying in their vicinity. These again appear large when compared with those in the healthy tissue, and this may be explained by the imbibition of albuminous material. The corneal corpuscles of the cauterized portion color but little ; their margin is indefinite and only to be known by a row of small black dots; those lying deeper are more easily recognized. Sometimes, we also see nerves in the cauterized portion, but only the thickest branches, and they have the same granular appearance that I observed in the corneal corpuscles.

The preparations of peripheral parts of corneæ which were cauterized 12–24 hours previously, show those round cells with one or more nuclei arranged in the same manner, as has already been described by Cohnheim. It was only seldom that I could convince myself of the presence of lime in the corpuscles. I took care not to draw any conclusions from this fact, in the gold preparations, because the use of tests can never give a reliable result in this direction.

Further on, I will mention the results which I derived from the gilding of the definite opacity ; now, I will return to the other form described by me, namely, to that in which the mass of epithelium, mixed with more or less large particles of lime, was not immediately removed, and where, in consequence thereof, the opacity takes that chalky white appearance which it presents during the process of ulceration and cicatrization. In this case we observe, besides the

above-described changes, an increase of thickness and an apparent petrification of the cornea.

Plate III., Fig. 3, represents a preparation of a cornea, whose centre presented, six days after cauterization, the described changes. In Fig. 2, the change from the cauterized to the sound tissue of the same object is delineated. From these drawings you can convince yourselves that the entire substance of the cornea (Fig. 3), and especially the layers of the same are filled with small granules which gradually disappear towards the periphery. Next to this abnormal tissue comes one less changed, which denotes the beginning of the process of regeneration, and then the epithelium (Fig. 2, *a*).

The petrified portion of the cornea is, especially after hardening in alcohol, peculiarly brittle, and in directing the cuts we have a feeling as if cutting something of a sandy nature.

I could observe in corneæ, with these changes, which I had watched for a length of time, that the petrified portion was totally covered by a newly formed tissue. This portion, as is easily believed, reacts to the test very strongly, and with the escaping of much gas (carbonate of lime). The granules disappear, the tissue is clear, and you can distinguish the layers and the corpuscles. In cases where the ulcerative process reached a considerable depth, I could observe, on the inner surface of the Descemetii, a layer of newly formed tissue, which presented, on perpendicular sections, much similarity to the corneal tissue. The endothelium covered the inner surface of this tissue, which

seemed to be shoved between it and the Descemetii, and whose periphery gradually lost itself in the endothelium of the Descemetii.

The observation has already been made by Donders, in his work called "Neubildungen von Glashäuten im Ange,"* and is represented in the accompanying Fig. 5. The only difference is that, in the cases observed by me, the newly formed tissue corresponded to the cauterized spot, and that between the same, and the epithelium covering it, as yet no newly formed glass membrane existed.

The lime causes great changes as well in the conjunctiva and sclerotica as in the cornea. The former seems peculiarly adapted to these from its anatomical structure. I have convinced myself of this, that even in cases where the conjunctiva has been but little cauterized, a large amount of lime has been taken up in the wide meshes of the episcleral tissue. The lime is found in the same in the shape of large globules (Plate III., Fig. 1), which can keep up an irritation of this and the surrounding tissue for some time.

The sclerotica itself does not absorb much lime immediately after the cauterization. However, it seems that the particles of lime, after having produced a violent inflammation with inauspicious results in the conjunctiva, may advance further and penetrate even into the sclerotica in considerable quantity.

I must briefly mention two very interesting conditions,

* Arch. f. Ophth., B. 3, Abth. 1., page 163.

namely, the infiltration of the sclerotica with lime in spots corresponding to the insertions of the recti, and the formation of sequestra at the cul-de-sac of the conjunctiva. The former occurs in such a manner that the entire tendon is petrified. The latter appears in the form of a piece of tissue, variable in size, which is completely petrified, and is detached from the neighboring parts, so that we can properly call it a petrified sequestrum (Plate IV., Fig. 5). In the same figure you can see the arrangement of the newly formed vessels. Some lie directly under the epithelium, and are in connection with those of the conjunctiva (*b*), the others are deeper, and seem to be a continuation of the subconjunctival vessels.

These two classes of vessels are in connection by means of anastomosing vessels.

Especially in the vicinity of larger vessels a considerable quantity of small round cells, with one or more nuclei, may be seen, which often contain a variable quantity of lime.

The granular tissue which takes the place of the detached portion of conjunctiva or cornea, contains the most lime. I have also observed more or less lime in the muscular fibres lying under the cauterized spot.

I must now speak of the results which I derived from the microscopical examination of the corneal opacities left after cauterization.

Under this head I consider all such, where after a period of from one to two months the opacity had not changed, and where the epithelium and Bowman's membrane had regenerated.

The examinations were made, as formerly, on alcoholic and gold preparations. The cornea was found thicker than usual on the cauterized spot, and this increase generally occurred in the direction of the anterior chamber. Perpendicular sections showed us that the epithelium, and especially the substantia propria of the cornea contained a variable quantity of small particles of lime.

The cells are more numerous on the spot where there has been a loss of tissue. This portion is distinguished by lines of spindle-shaped cells, or of such with several communicating processes; some of these have even a very deceiving resemblance to the fixed corneal corpuscles, with this difference, that they are more numerous, and that their projections are comparatively thicker, and also that their course is more irregular, so that the intercellular substance is not represented as in a normal cornea by lamellæ, but by a regular areolar mass which resembles the intercellular substance of the cicatricial tissue (Plate IV., Fig. 6, *c*).

The perpendicular section of the gold preparations (Plate IV., Fig. 6) is very instructive. In the case described there, the cicatrix takes up about half the thickness of the cornea. This portion has acquired a dark violet color from the gilding; we see how it diminishes in thickness, and gradually terminates in a well-defined line. Posteriorly, the cicatricial tissue gradually loses itself in the comparatively normal corneal tissue; anteriorly it advances to Bowman's membrane, where centrally situated papillary prominences are seen: then comes the membrane

just mentioned (*b*), which is here somewhat thicker than at other places ; and finally the newly formed epithelium with a smooth and regular surface (*a*).

It is a very interesting fact, that completely developed nerves can be found in the cicatrix, which they traverse in different directions, and which can be found ending in the epithelial layer (*d*). In some opacities, whose regeneration was not yet completed, we could see, in the most superficial layers of the cicatrix, a large number of spindle-shaped elements standing closely together.

Longitudinal sections seem peculiarly favorable to the study of the form of the cells, and the communication of their processes. In the sections we can convince ourselves of the fact that they have the greatest resemblance to the normal corneal corpuscles.

The other half of the cornea, which had been hardened in alcohol, showed that the largest amount of lime was generally found in the neighborhood of those rows of cells which I have described as the cicatrix. The regenerated epithelium, which covers the cicatrix, as well as the corneal substance posterior to it, also contained some lime, although not so much. The test with sulphuric acid showed in this case a total disappearance of the lime granules, and a considerable precipitate of crystals of sulphate of lime with a little evolution of gas.

Whether the regenerated nerves also contained lime, I can not say, since I could only see them in gold preparations; I consider it, however, improbable. As regards the glass membranes, they were free from lime. The membrane of

Descemet contained in some cases (Plate III., Figs. 2 and 3) small granules of lime.

THERAPEUTICS.

The occurrences above described, of course, led me to experiment, and see whether I could clear up the opacity on living animals by a methodical use of acids; this had already been tried, by various authors, on man, and by *V. Graefe** on animals without satisfactory results. I am very sorry to say that I am also unable to mention any favorable results. I used various acids (chromic, muriatic, and acetic acids) in very strong dilution, without having been able to notice any diminution in the opacity, after several weeks' treatment; but I have not yet given up all hopes on the subject.

Another proceeding which gave better success, was the abrasion of the cauterized portion immediately after the cauterization. I succeeded in this manner really in an astonishing degree, especially if I was able to abrade the entire dimmed portion.

In such cases, the complete regeneration of the removed portion took place in a very short time, and with perfectly transparent tissue, which fact had already been

* V. Graefe writes: Chemical antidotes, as for instance, the careless and not recommendable washing of the eye with diluted vinegar, could, perhaps, have some influence on the portion of the lime not yet in combination; however this can be better removed mechanically or involved with oil. At all events, we could only use it once, for the vinegar irritates the eye very much. These remedies have no influence whatever on the opacity already existing, of which fact I have convinced myself by experiments on animals (loc. cit., page 238).

confirmed by Donders, by experiments on animals, and by other authors on man. But this remedy, which seems very good for exceptional cases, where the cauterization is confined to a very small portion of the cornea, can not be thought of in cases of burning of the entire cornea, or in such where the entire thickness of the cornea is affected. This fact proves, however, that the lime which was found in the cicatrix, and occasioned its specific opaque character, must have been furnished during the cicatrization by those particles of lime which had pushed themselves forward into the substance of the cornea immediately after the cauterization.

From that which has been said, I believe myself justified in drawing the following conclusions:—

1. The first change brought about by the burning of the cornea with lime is a destruction of the epithelium, the remains of which, mixed with a large quantity of lime, form a detritus.

2. If the lime has remained for a short time in contact with the cornea, it not only causes a more or less deep destruction of the substance of the cornea, by the rapid withdrawal of the fluid with which the cornea is impregnated; but it also penetrates in variable quantity into the substance of the cornea in the shape of small, dust-like particles.

3. A large portion of the cauterized tissue is cast off during the inflammatory process, and is replaced by a cicatricial tissue containing lime.

4. If the destroyed epithelium, mixed with lime, is not immediately removed after the injury, it happens very

often that a true petrifaction of the substance of the cornea, besides the changes caused by the cicatrix, takes place.

5. The substitution of the detached corneal tissue is brought about by a cicatricial tissue, which is very cellular, and whose cells anastomose with one another in every possible way.

6. The cicatrix contains nerves which show the same anatomical arrangement as in a normal cornea, and whose terminations can also be followed into the epithelial layer.

7. If the cauterized portion of the cornea is removed, a white opacity does not result; on the contrary, the substituted tissue is clear and transparent.

8. In cases of burning of the conjunctiva with lime, the lime advances with ease into the episcleral tissue, in the form of globules of different size, which can at a later period form extensive incrustations on the sclerotica and the adjacent muscles, and thus increase the danger of the injury.

9. The opaque white and irremovable cloud is, at least for the greater part, occasioned by the presence of lime in the cicatrix.

In conclusion, I express my best and warmest thanks to my highly respected teachers, Prof. J. Arnold and Prof. O. Becker, for their friendly aid.

Explanation of the Figures in Plates III. and IV.

PLATE III.

Fig. 1.—Cornea, sclerotica, conjunctiva, &c., immediately after cauterization.

H. Cornea impregnated with minute particles of lime.

S. Sclerotica.

N. Plica semilunaris.

a. Epithelial detritus of the cornea, mixed with lime.

b. Particles of lime between the plica semilunaris and the sclerotica.

Fig. 2.—Cornea, six days after cauterization, incrusted with lime.

a. Anterior epithelium.

b. Corneal substance impregnated with small lime granules.

c. Membrane of Descemet.

Fig. 3.—A piece of the centre of the cornea of the same case.

b. Posterior portion.

Fig. 4.—H. Cornea.

C. Conjunctiva.

C′. Subconjunctival tissue impregnated with globules of lime.

M. Insertion of the muscular fibres and a rectus muscle on the sclerotica.

S. Sclerotica.

d. Membrane of Descemet.

u. Infiltration of lime in the tissue at the corneo-sclerotical juncture.

I. Iris.

Plate IV.

Fig. 5.—H. Cornea.

a. Epithelium.

b. Newly-formed superficial corneal vessels.

c. Newly-formed deep-lying corneal vessels which, especially in

d. are surrounded by many cells.

C. Conjunctiva.

e. Vascular net of the conjunctiva.

b. Subconjunctival vessels.

M. Muscular insertion of a rectus in the sclerotica.

S. Sclerotica.

V. Petrified tissue in corneo-sclerotical juncture.

I. Iris.

Fig. 6.—Corneal cicatrix, two months after injury, treated with chloride of gold.

a. Anterior epithelium.

b. Bowman's membrane.

c. Cicatricial tissue.

d. Nerves of the cornea.

e. Membrane of Descemet.

f. Endothelium.

THE GALVANIC REACTION OF THE NERVOUS APPARATUS OF HEARING, IN CONDITION OF HEALTH AND DISEASE. CONTRIBUTIONS TO ELECTRO-OTIATRICS.

By Dr. W. ERB, Professor in Heidelberg.

Translated by J. H. Pooley, M. D., of New York.

It might be supposed that a work so full of care, and earnest effort, and of such constant and consistent results, as that of Brenner on Electro-otiatrics,* would on no side be open to serious contradiction, least of all on that, in the special interest of which the work was undertaken. Nevertheless, the phenomenon so often recurring in the history of the galvanic irritation of the acoustic nerve repeats itself again here; the observers who next undertook these researches have conducted their examinations with but little skill, and arrived at only negative results. Instead of finding the reason for this in their own unskillfulness, they preferred to declare the well-founded matters of fact, which

* R. Brenner.—Researches and Observations in Electro-therapeutics. 1. On the effects of the electric current on the auditory apparatus in healthy and diseased conditions. An attempt at founding a System of Rational Electro-otiatrics. Leipzig, 1868.

Brenner had advanced, erroneous, if no worse. They even went so far in their holy zeal, as to deny the importance of the unassailable propositions of rational electro-otiatrics for the cure of aural diseases, and yet at the last meeting of the Society of Natural History at Dresden, it was seen from what a one-sided stand-point, and with what poor reasons a certain party opposed the clearest and simplest researches of Brenner, and the inferences which they lead every scientific critic to form. If observers to whom the application of the galvanic current to the finer electric researches of the nerves of the human body is an unaccustomed task, and therefore can not be easy, have not succeeded in their experiments on the galvanic excitement of the nervous apparatus of hearing (which even in the healthy often presents great difficulties), it is easy to explain, and may be pardoned, although a little more modesty in judging of these disputed questions would have been desirable; it is, nevertheless, very unpleasant when people who have made experiments with electricity the business of their lives, have in similar experiments met with like failure.

Even Brenner's researches have not wholly escaped this depressing experience: there are electro-therapeutists who are possessed of the enviable courage to declare, notwithstanding such positive and so many times publicly demonstrated results, that they have found it impossible to excite the nervous apparatus of hearing to its specific functions by the galvanic current; from which, in the belief of their own infallibility, they have drawn the inference, that such excitement was really impossible, in other words, that

Brenner knowingly or unknowingly had deceived the scientific world.

In spite of all this, in spite of all the verdicts given by modesty or arrogance, Brenner's results are in their principal points correct throughout, and, with some skill and practice, may be constantly controlled and produced; indeed they have already been confirmed by a few observers in many points. It depends evidently only on the imperfection of the method, or unskillfulness in the application of the galvanic current, that many observers only arrive at negative results. *Those who deny the existence or the correctness of the matters of fact discovered by Brenner, are simply in error.* To prove this, or at least to produce some of the material necessary for the proof, is the purpose of this essay. I publish the same only in the interest of the thing in hand, the bearing of which appears to me of such importance for the electro-pathology of the nervous system, without considering otology, that every effort ought to be made to confirm, beyond a doubt, the fundamental principles here in question. My paper makes no further pretension except to confirm and illustrate, as far as possible, the results obtained by Brenner; it does not yet reach any further than the results he has brought forward.

Stimulated by some unpleasant assertions not at all honorable to their originators, which I have heard in Dresden, and by the conviction already produced by preceding observations that Brenner's assertions are for the greater part true, I have undertaken a more extensive series of experiments, the results of which I hereby publish.

I hope that there will be found in my position, which is unconnected with the efforts of aural surgery and particularly individual aurists, on the one side, as well as in my occupation for many years with electro-therapeutics and neuro-pathology on the other, sufficient guaranties for the reliability of the results which I shall communicate in what follows. These are, as I remarked at the beginning, in all essential points confirmatory of the assertions of Brenner, regarding physiological relations, as well as the few pathological cases which have occurred to me so far.

I will first communicate the results of experiments on physiological irritation, because they are from my standpoint of the greatest interest, and have, until now, been the least confirmed; then I shall add the report of some pathological observations which have come in my way.

THE GALVANIC IRRITATION OF THE NERVOUS APPARATUS OF HEARING IN A PHYSIOLOGICAL CONDITION.

It is no doubt correct, from a purely scientific standpoint, that when an agent is recommended as a remedy, it is of the first importance that its physiological rationale be understood.

From this it is justifiable to make the effort to discover such a physiological basis, but the therapeutic application is by no means dependent on the discovery of such a basis. One must not, therefore, reject the galvanic current as a curative means for certain nervous diseases of the ear,

because some aurists have not succeeded in bringing the normal acoustic nerve to a reaction in accordance with known laws. How many of the remedies in use in aural surgery, particularly in nervous affections of the ear would remain, if before admitting them we should rigidly exact a physiological reason or basis for their use? This physiological basis is by no means easy to determine with justice in dealing with the nervous apparatus of hearing, as I have often been convinced. Nor should we *a priori* have expected it to be otherwise. Few nerves of the body are surrounded with so many impediments to the application of the galvanic current, almost everywhere a very dense substance of bone is the medium of conduction; the dry membrane of the tympanum, the air-containing cavity of the tympanum, which is only bridged over by the little bones of the ear, are great hinderances to the passage of the galvanic current, especially to a current of so little force as can, in the nature of things, be applied to the head. It may, therefore, be *a priori* expected that in many cases only with difficulty or not at all, will it be possible to excite galvanically the nervous apparatus of hearing; that, furthermore, manifold apparently abnormal phenomena will arise on account of the complicity of the given relations; nevertheless, from a great number of cases, certain legitimate rules of conduct may be deduced. How much more favorably are most of the motor nerves of the body situated for the influence of the galvanic current! And yet every one who has only occupied himself superficially with such researches knows what enormous differences they show in

regard to their galvanic excitability; how difficult it is with some individuals to prove clearly the law of contraction of the motory nerves. And yet no sensible person will deny that the motor nerve reacts on the galvanic current according to a certain law. Even in regard to these every-day repeated observations on the motor nerves, it must appear perfectly remarkable with what clearness and regularity the phenomena of excitement present themselves in the nervous apparatus of hearing. From this may be deduced the simple rule not to expect and force a favorable experimental result from every single case, and not to deduce from single failures the impossibility of representing in any degree these phenomena of excitement in a legitimate and determined formula.

I shall now be obliged to occupy myself in what follows with the technical difficulties of galvanic excitement of the acoustic nerve, and shall point out, somewhat in detail, the means by which they may be overcome.

I shall not have to say much that is new with regard to the precise method of producing the excitement. I am sorry that the account will have to deal with a multitude of technical details, but I hope by this means on the one side to make easy to my successors the statement of the more important results, and again to give some information to those who have not been successful in their researches with regard to the causes of the failure of their experiments. I hope by this means to convert the doubting or skeptic. I used, in most of my experiments, very imperfect apparatus, for it was only towards the end that I

obtained a "Rheostat," and a "Siemens-Halske's commutator."*

Nevertheless I have generally attained my end. I have commonly used a Stœhrer's battery with a closing bar, in which the number of elements could only be changed by two. The closing and opening of the current was accomplished by hand, with a wire immersed in mercury, changing the direction of the current with a metallic commutator; where in the following statement it reads *Volt. Alt.* (voltaic alternatives), it signifies a rapid change in direction of the current with the closed chain; where simply turning of the anode or kathode is mentioned, the current was first

* I will insert here a few remarks for such as use this apparatus; it may perhaps be useful. The commutator or current-turner is, especially in Brenner's new form, exceedingly convenient and useful. It serves, at the same time, for the interruption and closing of the current, and permits the slow and quick entrance of the voltaic alternatives. I am exceedingly satisfied with this apparatus. I was not so at first with the Rheostat, as long as I used it in a Stœhrer's battery with the old cylindric elements. I was not then able to effect a sufficient diminution of the current with the Rheostat alone. As even six and four elements, with only ten resistances in the secondary closing with me, and some of my patients with hyperæsthesia of the auditory nerve, produced sensations of sound. But for two days I have used one of the new Stœhrer's batteries, with plate-elements, and I am now perfectly satisfied with the operation of the Rheostat, and find it quite in accordance with Brenner's assertions. I am inclined to refer the effects to the different sizes of the surface of the elements in the two batteries; for if I with the cylindrical elements (which have a much larger surface) close and open the current, at a certain intensity. lively sparks are produced, while in the batteries with the plate-elements, with the same number of elements, and the some physiological conditions (*i. e.*, the same intensity of current by inserted great resistances of conduction), at the metallic interruption none, or only quite weak sparks are observed. This must be further investigated. I will only, in passing, make these remarks, to save others who, perhaps, may have some difficulty, trouble, and vexation over the apparently insufficient operation of the Rheostat. With a battery of elements with relatively smaller surfaces, the same appears to be an excellent means for the graduation of the intensity of the current.

opened in one direction, then the commutator transposed, and then again the chain closed in the now altered direction. The galvanic excitement of the acoustic nerve presents, in many healthy persons, very considerable difficulties. One of the greatest hinderances to the success of the attempted experiment is pain, which is particularly severe if we introduce the ear-electrode into the auditory passage when filled with salt water. The pain then quickly increases, even with a current of moderate intensity, to a degree altogether intolerable; this I have repeatedly experienced in my own person; and if, notwithstanding, I continued the experiment, slight attacks of syncope occurred.

A very high degree of sensibility of the auditory meatus and membrana tympani occasionally manifests itself, especially with individuals of a superior degree of intelligence; we meet with this hyper-sensitiveness also very frequently if we touch the sides of the meatus or the membrana tympani with a probe or some other instrument.

In persons suffering from aural disease, this sensibility is far less manifest: partly, perhaps, because it has been blunted by numerous manipulations; partly, also, on account of anatomical changes in the tympanum; or, lastly, because the walls of the auditory passage have been changed in a favorable manner by the long-continued application of astringents. So far no expedient has been discovered to obviate this manner of application from pain, and very short sittings are all that can be borne, by which, however, some very characteristic phenomena are lost. The pain is

greatly moderated if, following Brenner, we place a somewhat larger electrode upon the tragus, and by this means close hermetically the auditory canal which has been previously filled with salt water. In this way the pain is localized upon the external integument, and thus much more bearable; but then certain secondary phenomena become more conspicuous, but they do not much disturb the observation. Pain is the most frequent cause of failure in these experiments; with many persons it renders the galvanic irritation of the nervous apparatus of hearing utterly impossible. In some cases I succeeded by introducing an electrode into the auditory passage, and then repeating the experiment after a long-continued application of the ear-electrode upon the tragus, even then it gave rise to great pain, which could only be endured for a short time. Dizziness and stupefaction are impediments which occasionally occur, but only with very sensitive persons, they commonly disappear after a few repetitions of the experiment. A sensation of nausea is sometimes produced by the too long-continued application of more intense currents, but it usually disappears again rapidly. The muscular contractions which sometimes occur upon closing the current, render observations upon the sensation of hearing very difficult; this is especially true of the striking together of the jaws by contractions of the masseters. The contractions of the facial muscles, and the phenomena of flashes of light before the eyes, are apt to withdraw the attention from the perceptions of hearing. They are especially apt to appear if the ear-electrode is applied externally upon the tragus.

Even the contractions of the arm, to which the second electrode is fastened, may act as disturbing elements. All these things deserve to be taken into consideration. There are, besides, some trifling advantages, by means of which the certainty and facility of irritation of the acoustic nerve may be increased; it is thus advantageous to use warm salt water for the filling of the auditory passage, and for moistening the electrodes, instead of common water. In closing the auditory passage with the electrode placed upon the tragus, attention must be paid to keeping the auditory passage always completely filled with liquid; if it is not completely filled, disturbing sounds are apt to occur. The position of the second electrode is certainly of great importance, not for the manner of irritation, of course, but only for the possibility of irritation. As we have to do with a very deep-lying nerve, it follows, from the simplest physical laws, that the second electrode must not be placed too near the ear electrode. It is, therefore, quite a faulty arrangement to place the second electrode upon the mastoid process on the same side.

It would be most conformable to the purpose to place it upon the opposite side of the neck, but this is perilous on account of the violence of the cerebral phenomena which then appear. It seems to be most practical, therefore, to let the electrode be taken in one hand; I have usually fastened it upon the back of the hand on the side opposite to the ear to be examined; the certainty of the experiment is thus increased, without causing too violent phenomena of dizziness, &c.

The galvanic irritation of the nervous apparatus of hearing is, notwithstanding all these precautions, still with many persons an extremely delicate and difficult operation; in many cases repeated sittings and gradual habituation to the disagreeable accompaniments will be required, before the sensations of hearing in the person examined will become clearly perceptible. If, however, this is once obtained, in the following sittings the desired irritation is accomplished easily and surely. A principal requirement for the success of the experiment is calmness and deliberation; we must understand how, by a careful realization of the manipulations to be mentioned, to produce the desired effects without too great annoyance of the person experimented upon; the more slowly we advance the intensity of the current the surer is the attempt to succeed. It is, of course, also of special importance how we question the person experimented upon as to the subjective phenomena. And the minute observations which *Brenner* makes on pages 85 to 87 in his book on this subject, deserve special consideration.

We shall only succeed in any case in effecting the sensation of hearing by closing the chain when the kathode is in the ear.* In cases where the success is imperfect, the longer closure with the kathode will augment the excitability in

* I follow here, quite naturally, Brenner's uncommonly practical directions. Ka = Kathode. An = Anode. S = closing (Schliesung). O = opening (Oefnung). D = duration of current (Stromesdauer), or duration of the closing of the chain. I shall also further designate the formula of the acoustic reaction in the same way. The sensations of hearing are designated according to their character by different letters, Pf = whistling. Kl = ringing. Z = hissing, &c.

such a manner that by following Ka S, sounds appear. We must also, by repeated closure of the kathode, augment the intensity of the currents.

But a far more effectual means is Ka S, after the anode has been permitted to operate for a longer time. The more rapidly the Ka S follows upon the An O, the more certain is the effect; most distinctly, therefore, with the so-called Volt. Alt., when the same are performed as quickly as possible with the current-turner. With a certain intensity of current we succeed in this way in obtaining a distinct sensation of sound at once. If this has once happened, it will usually remain even with a much lower intensity of the current and a simple Ka S. With most healthy persons it is more difficult to obtain a reaction with An O, it appears only with much greater intensity of current than the reaction of Ka S. It is known from experiments upon *Electrotonus* and the law of contraction of the motor nerves, that the excitability of the nerves for An O increases with the intensity of the current and the duration of its closure. Success, therefore, depends upon advancing slowly, in prolonged duration of closure, to the highest bearable intensities of the current, and then suddenly opening the chain. We begin, therefore, An S with a low intensity of current, and increase it more and more during An D, at the quick opening of the chain there is then manifested the beginning of sensation, but frequently only after repeated trials. I am aware that in this I do not advance any thing new, it has been done and better set forth by Brenner, and yet it appears necessary to repeat it again, until we are accustomed to the

experiments so as to conduct them with all the necessary circumspection. The purpose may in this way be obtained with most people. Only with a few healthy persons I did not succeed, even after repeated experiments, and this was on account of their hyper-sensitiveness. A good criterion, whether the necessary intensity of current is reached, is offered by the contractions in the facial region, especially if the electrode has been introduced into the auditory passage. When they do not appear we may be sure that the intensity of the current is not high enough. They generally appear soon after the electrode has been placed upon the tragus, and are then occasioned by the excitation of the external branches of the nerve. Where the acoustic reaction appeared at all, and distinctly, it was in all healthy persons always and without exception according to Brenner's normal formula, if there was any irregularity of the reaction it was quite unmistakable. In our special case it must be mentioned that the observer himself must have had a considerable amount of practice in the carrying out the necessary manipulations. I have experienced this myself, for although not inexperienced in the technicalities of galvanic researches, I have at present, after several months' practice with this object, acquired a much greater facility and certainty in obtaining acoustic reactions than during the first weeks of my experiments. It is therefore advisable for beginners and unpractised persons to make their first experiments on persons suffering with diseases of the ear, who offer more favorable conditions, and only afterwards to proceed to the examination of healthy persons.

I will give first the results of experiments on persons with perfectly normal ears, or at least with such persons in whom no disease of the nervous apparatus of hearing could be discovered.

I begin with the results which I have obtained on myself, as they offer a very good example of the difficulties which present themselves in the examination of healthy persons.

1. W. E., 28 years old, never suffered from disease of the ear, perfectly normal hearing, ears quite healthy by objective examination. Auditory passage very narrow.

Right Ear.—An electrode of hard gum provided with a little metallic button and a sponge covering, shaped like a common ear-funnel, is introduced into the auditory passage, which is filled with water, the second electrode is fixed upon the back of the right hand.* Experiments many times repeated, and even with from 18 to 24 of Bunsen's elements, were with this arrangement without result. Very violent pain, muscular contractions, dizziness, and nausea appeared, but of sensation of sound I could perceive nothing. I exchanged the water for warm salt water, and applied B to the back of the left hand. By this means I succeeded, on the 16th of October, 1868. The effect of the current was now much more violent; even with from 6 to 10 elements exceedingly acute pain was felt; the Ka produced a very violent stinging pain, with burning, which could even be felt in the fauces, whilst the An produced a violent, but more tolerable pain, which extended inward. With 10 elements the first sensations of sound appeared, with Ka S a distinct and

* I shall, for brevity's sake, mark this manner of experimental arrangement, whereby the ear electrode is introduced into the external auditory canal, in the following experimental records, as "inner experimental arrangement;" I shall call it "external experimental arrangement" when the canal is closed by a somewhat larger electrode (1¼ centimetre in diameter), placed upon the tragus. The second electrode I shall always designate as B.

loud ringing, similar to spontaneous tinitus, of distinctly metallic character, corresponding in pitch to the highest tones of the newer pianos, it became louder and more distinct after repetition of Ka S, and after current-turnings.

The An S and An D gave no distinct sensation of sound; the An D reaction is very difficult to obtain; only with 10 elements and longer duration of closure is a short, weak sensation obtained with An O of the same character as with Ka S. Eight and six elements gave only Ka S reaction. From the foregoing the following formulæ are deduced:—

10 El,	Ka S Kl	8 and 6 El,	Ka S Kl
	— D Kl >		— D —
	— O —		— O —
	An S —		An S —
	— D —		— D —
	— O Kl		— O —

The accompanying phenomena have been very various in these experiments; pain uncommonly violent, at last quite unbearable; feeling of dizziness quite insignificant; facial contortions not very marked; flashes of light always present; sour taste, especially with An D; afterwards sensation of impending syncope. I have, in the experimental arrangement on the external ear, filled the auditory canal with salt water, repeated the experiments many times, and always obtained positive results; only there was then a somewhat higher intensity of current required. With 12 elements first appears Ka S Kl (loud, high-sounding); with from 14 to 16 elements I succeeded first, after a very long duration of closure, in obtaining the An O reaction. The An S and D gives, at this intensity, no certain sensation of sound; while with An D I hear only a weak, soft, continuous rustling, which remains unchanged until the chain is opened; this does not appear upon repeating the experiment

without water in the auditory canal. The accompanying phenomena are somewhat different in this arrangement; the pain is in proportion much less, the facial contortions less, but the contraction of the masseter much stronger, so that they easily distract the attention from the sensations of sound, dizziness, phenomena of light, sensations of taste, varying somewhat according to the poles.

Left Ear.—External arrangement, no water in auditory canal. With 12 elements, there appears first at Ka S Kl (ring, quite similar to the right ear), which continues for some time, and disappears completely with the continued Ka D; Ka O gives no sensation; An S and An D give no trace of sound, not even with 16 elements; after a longer An D with this intensity at An O there appears a very distinct, short sensation of sound, similar, only weaker, as with Ka S.

This experiment, though often repeated, gave constantly the same result. The accompanying phenomena were the same as in the right ear.

2. Anton Rheinstein, 24 years old, merchant, muscular man, under galvanic treatment for a slight degree of impotence. Ear on both sides quite normal, hearing power quite normal, suffers from pain in the bones, never had any thing the matter with his ears.

12*th November*, 1868. *Right Ear.*—There had already, for two days back, been ineffectual attempts made to excite the acoustic nerve with the internal arrangement. Therefore to-day the external arrangement was made use of (B on the left hand, meatus filled with salt water), and a current from 12–18 elements made use of for some time, in varying direction; there were produced the ordinarily observed accompanying phenomena, but no sensation of sound. It was then suddenly changed for the internal arrangement, and immediately with 8 elements Ka S Kl there was perceived a clear, loud, and high whistling, with extremely acute pain. This was also afterwards obtained with 6 El Ka S, and even with 4

Volt. Alt. on the Ka, with great distinctness. But the An O reaction was much harder to obtain. I succeeded, at last, in the following manner: the current was closed with An in the ear, and with 4 El; after An D of one minute, without opening the chain, the force of the current was raised to 6 El; the pain became very violent; in 15 seconds more, 8 El; pain almost unbearable; at the end of a few seconds more, 8 El An O Kl, *i. e.*, a distinct, pretty loud, but short whistling; repetitions of this experiment gave an entirely similar result. The accompanying phenomena, except the pain, were very little changed.

3. Michael Reinhard, 31 years old, agriculturist, under treatment for atrophy of the muscles of the lower extremity, and nearly cured. Both ears quite normal, auditory meatus large; hearing-power and conduction through the bones quite normal; never had any thing the matter with his ears.

Right Ear.—External arrangement, meatus filled with salt water, B on the left hand. The experiment was begun with a protracted closure of the kathode; first, with 16 El, there appeared a distinct, loud, but rather short, high-toned whistling. Following Brenner's terminology, the primary excitability of the acoustic nerve would here be expressed by 16 elements. Diminishing the strength of the current, it appeared with 14 and with 12 El Ka S Kl, but not with 10; the secondary excitability is therefore expressed by 12 El.

I now tried to obtain the An O reaction, but only succeeded with difficulty; the means used for this purpose were prolonged closure, and augmentation of the strength of the current, in the following manner: An D 12 El, $\frac{1}{2}$ min.; 14 El, $\frac{1}{2}$ min.; 16 El, $\frac{1}{2}$ min.; An O, no reaction; An D 14 El, 1 min.; 16 El, $\frac{1}{2}$ min.; 18 El, $\frac{1}{2}$ min.; An O Kl, a short but pretty loud whistling. An S and An D gave no result with any intensity of the current, even with 18 El, and this was particularly noticed, only a trace of sound sensation; even the light rustling occasioned by the fluid in the ear was not in the least

changed by it. With 16 El we succeeded in restoring very completely the normal formulæ, after several current-turnings and the practice of various manipulations, even with 12 and 10 El.

With 8 El sound only appeared with Ka S; with 6 El only a very weak sensation after Volt. Alt. The tertiary excitability is therefore indicated by these numbers.

The accompanying phenomena varied in no remarkable degree; pain moderate, the contortions of the facial muscles followed the well-known laws of contraction of the motor nerve, dizziness moderate, sensation of taste, particularly with An D. Immediately after this experiment, the membrana tympani was of a rosy hue, the handle of the malleus, as well as the walls of the meatus, strongly injected.

Left Ear.—The same experimental arrangement gives exactly the same results. With 16 El Ka S the first sensation of sound made its appearance, similar to that in the right ear, as a high, loud ringing or whistling. With the An O reaction and the ordinary manipulation, a short whistling was obtained with 18 El and still more distinctly with 20; the secondary and tertiary excitability made their appearance in the same way as on the right side. The accompanying phenomena were also similar. An S and An D gave no sensation of sound with any intensity of current.

4. Ludwig Goller, 34 years old, peasant, under galvanic treatment for peripheral paralysis of the muscles of the right arm, hears perfectly well, has never had any disease of the ears.

Right Ear.—Hearing distance normal for speech and the watch conduction through the bones good, meatus healthy, membrana tympani somewhat thickened, and cloudy without light spot. External arrangement, meatus filled with salt water. With 14 El Ka S after An D and An O there immediately appeared a whistling which lasted some time, but disappeared before Ka O. An S and An D gave no reaction. With 16 El we succeeded by the manipulations already described in obtaining with An O Kl a short, weak

whistling, which became louder and more distinct with 18 El. We succeeded, by augmenting the intensity of the current, in completely restoring the normal formula even with 10 El. With 8 El Ka S whistling still ensued, and even with 6 El with Volt. Alt. on the Ka. Accompanying phenomena very slightly developed.

Left Ear.—Hearing distance and bone conduction normal. Meatus normal. Drum head somewhat cloudy, without the light spot. Arrangement of experiment, as in the right. Here also with 14 El Ka S, the first sensation of sound, of the same character as in the right. With 16 and 18 El An O Kl succeeded. Ka O An S, and An D remained in every intensity of the current unanswered by sound sensation. The higher grades also of the nervous excitability may be represented as in the right. Accompanying phenomena quite as slightly developed, and took place in a distinct and regular manner.

5. George Ph. Schmitt, 50 years old, day laborer, under galvanic treatment for progressive muscular atrophy.

Never had any disease of the ears; hearing on both sides quite normal, right drum head somewhat cloudy; left, normal, meatus unchanged.

Right Ear.—Internal experimental arrangement, B on the left hand, 4 El, 6 El Ka S—no reaction.

8 El Ka S	Pf,	clear whistling, stinging pain, facial contortions.
— D	Pf,	gradually disappeared.
— O	—,	no sensation.
An S	—,	violent pain.
— D	—,	pain remains.
— O	Pf,	short and weak whistling, slight facial convulsions.

With 10 El the same formula gave still louder sensations of sound, but the accompanying pain was very severe.

With continuous current-turnings the normal formula was fully restored with 6 and even with 4 El; with 2 El appeared only Ka S Pf, with An O no further reaction.

Left Ear.—With the same arrangement exactly the same results were obtained. With 8 El the first sensation of sound appeared at Ka S, and then also the full formula; the normal formula was clearly perceptible on this side with 6 and 4 El. With 2 El Ka S Kl appeared only with Volt. Alt. but distinctly. Accompanying phenomena, with the exception of pain, moderately developed. With An D some dizziness and sensation of taste; muscular contortions most perceptible with Ka S; weaker with An O and An S. Reddening and injection of the drum head and its neighborhood after each sitting.

6. Franz Brod, 32 years old, plasterer, under treatment for lead palsy, has never had any disease of the ears; hearing perfectly good.

Right Ear.—Hearing distance normal for watch and speech conducting power of bones present. Meatus and membrana tympani perfectly normal. External arrangement, meatus filled with salt water, B on the left hand. After repeated closures in various directions there appeared with 10 El, Volt. Alt. Ka S, a weak, clear sound (whistling), which, with 12 and 14 El, became very strong and loud, and remained for a long time. Ka O, An S, and An D, gave no sensation of hearing. An O Kl is only obtained distinctly after very long duration of closing, with gradually increasing intensity of current from 8 to 16 El, but then appears distinctly with 14 El. Accompanying phenomena, pain, sensation of taste, facial contortions, dizziness, are developed in the usual manner.

7. Mr. M., 40 years old, musical director, under treatment for violin-players' cramp, had in early youth a discharge from the left ear, but says he hears perfectly well, at any rate is not annoyed in his profession by any deficiency of hearing. Patient has diminished bearing distance for the watch (his own watch on the left side 1½

ft., right 3 ft.); for speech no diminution was discoverable. Meatus on both sides quite normal. Membrana tympani on both sides quite clouded with deposits of lime. No rustling had ever existed in the ears.

Right Ear.—External arrangement, salt water in the meatus, B upon the right hand. With 10 El Ka S, high metallic ringing; with 12 El the same becomes much louder, continues pretty long, and only disappears quite gradually. Patient describes it as a ringing metallic sound, somewhat like that from a tuning-fork, and states it to be as high as g or gis in the highest octave of the piano. With 14 El An O, after a longer duration of closing, a similar, but shorter and softer ringing is produced. Ka O, An S, and An D give, with 10, 12, and 14 El, no trace of sensation of hearing. With 8 El the full formula is obtained; with 6 El, Volt. Alt. Ka S Kl is still obtained. Accompanying phenomena very moderate, but present in the ordinary manner. The sensation of pain with Ka, patient describes as stinging; with An, more dull and pressing.

Left Ear.—External arrangement, without water in the meatus; with 10 El, after preceding current-turnings; with Ka S, the first weak ringing, which grows much louder and stronger with 12 and 14 El; here likewise a distinct musical, very high ringing sound, as if proceeding from a fine table-bell, with a very high tone, which keeps on sounding pretty long, but not until Ka O. Ka O, An S, and An D give up to 14 El no trace of sensation of sound. An O with 14 El, after a longer duration of closing, a weak short ringing. Accompanying phenomena moderately developed.

8. George Fuss, 55 years old, farmer, on account of disease seated probably in the centre of the bulbus med. oblong., suffers from uncomplicated hyperæsthesia of the left acoustic nerve. (See farther below; compare also Transactions of Natural Historical Society of Heidelberg, vol. ii., p. 211.) The right ear, on the contrary, is perfectly sound; acuteness of hearing, membrana tympani, bone conduction, and so on, quite normal; gives, with external arrangement,

water in the meatus, B upon the right hand, the normal formula perfectly with 14–16 El, and down to 10 El with Ka S, sensation of sound (a high, fine, ringing whistling) is easily obtained. Ka O and An S always without reaction.

To these results I may add further, that with three other persons I did not succeed in obtaining distinct sensations of hearing. Two of them, to be sure, were made at the beginning of my experiments, and I can not therefore consider them of any consequence. With the third it was impossible to continue the experiment any length of time on account of great pain. From the facts above communicated, from the number of persons operated on, and the number of times the experiments were repeated with uniform results, it follows beyond a doubt that the nervous apparatus of hearing can be excited by the galvanic current, and that it responds to this excitement in a regular manner, with sound sensations. I hope it will not, in view of such regular and positive results, again be denied that the apparatus of hearing may be excited by galvanism. Perhaps some few confirmatory points may be deduced further from the short considerations which follow below of the negative results in others, which may give an explanation, and even show the cause of this want of success. I have gained from my experiments the sure conviction that it is in most cases possible, with some skill and patience on the part of the observer and of the person operated upon, to produce sensations of sound by means of galvanic excitement. Patience, self-denial, and some talent for observation is of course required in the persons experimented upon, in order to arrive

at correct results; it is only after repeated experiments that it becomes easy at once to comprehend correctly the sensations experienced.

What does not succeed, therefore, the first time, must not forthwith be declared impossible. I have already stated that great patience and skill are necessary in the observer to obtain positive results. From what has been said, and from facts positively stated by reliable observers, it can not well be denied that the nervous apparatus of hearing reacts upon the galvanic current in a manner fixed by natural laws. The constancy of the results in repeated cases is so great, that no question can be raised by any occasional irregularity of the reaction. As will be seen my results are in perfect harmony with the facts observed by Brenner on numerous persons. According to my experiments the normal formula is likewise apparent (for a certain intensity of current, which differs somewhat in every individual) in the following manner:—

Ka S Kl,	distinct, accented sound.
Ka D Kl >,	sound disappearing by degrees.
Ka O —,	no sensation of sound.
An S —,	" "
An D —,	" "
An O Kl,	weak and short sound, similar in character to Ka S.

This normal formula is of course only valid for those medium current intensities which are generally applicable to the head. The effect of higher current intensities is of

importance from a medical stand-point, as they are not generally applicable to the head. From the same stand-point it is of little interest to us to know in what manner the galvanic current will operate upon the bared, isolated, and abused nervous apparatus of hearing; we shall never be able to excite it in an isolated manner in the living body. We have first simply to examine in what manner under given anatomical relations the nervous apparatus of hearing reacts upon the galvanic current; in spite of the haughty sneers of certain physiologists who look upon such endeavors with distrust, I believe we now possess in the regularity of the galvanic reaction of the apparatus of hearing a sufficient guaranty, that, under the given anatomical relations, a certain influence of the galvanic current upon this apparatus is possible, and that the influence will always be followed by certain regular phenomena.

We accept this as true, all the more readily as the results of this excitement, as already shown, circumstantially, by Brenner, are in such striking harmony with certain facts which are undisputed in physiology, viz., with Pflüger's law of contraction, and with the doctrine of the polar effects of the galvanic chain.

The facts communicated above teach that under the influence of Ka the nervous apparatus of hearing only responds with a sensation of sound upon the closing of the chain, and remains on the contrary unexcited on the opening of the chain; that under the influence of An on the contrary the closing gives no response, while on the opening of the chain a sensation of sound appears somewhat weaker

and shorter than with Ka S. These facts are in perfect concord with the laws laid down by Pflüger, Von Bezold, and others, for the motor nerves (and likewise for the sensory nerves); upon closing of the galvanic chain the excitement only takes place at Ka, upon the opening on the contrary only at An. The excitement with Ka S appears sooner and is stronger than with An O.

The same laws have been recently established with cogent reasons also for the contractile substance of striated muscular fibre.* This much at least seems certain from all these researches that the current direction in the nerve or muscle is completely immaterial for the production of either of these polar effects; it is only of some influence on the conducting power of the exciting polar effects in a definite direction (*i. e.*, with other words, upon the appearance of muscular contraction on one side, and sensation on the other), because even on the poles, besides the exciting effect, influences will appear which hinder conduction. In the immediate neighborhood of one of the poles its specific effect will always appear.

If we therefore succeed in bringing a nerve or a particularly excitable part of it (say its terminable fibres) under the influence of one of the poles, its specific effect will always soon appear. The facts above stated teach us that it is possible to bring the nerves of hearing, or at least single parts of it, sufficiently under the influence of one pole, although it may be perfectly impossible to state

* Th. W. Egelmann, Ueber die Reizung der Muskelfaser durch den constanten Strom. Jenaische Zeitschrift für Medicin iv., 295–306.

the direction in which the current passes through the nerve of hearing itself.

The regular appearance of the polar effect in question shows that this effect is in every case the preponderating one. Under the influence of Ka we experience, therefore, a sensation of closure in the ear, under the influence of An only a sensation of opening. It is highly striking that not even with higher current intensities, as it is possible also in the motor nerves to obtain the closing sensation with An, and the opening sensation with Ka. It is difficult to give a satisfactory explanation of this fact. The direction of the current in itself, which is perhaps conditioned upon the position of the nerve in the petrous bone, or the influence of the poles which hinder conduction, can, with a centripetal nerve, and by the only current direction anatomically possible, by no means account for the non-appearance of the phenomena of excitement. It seems to me simplest to accept that only the extreme fibres of the acoustic nerve are able to be excited by the galvanic current, and that they always come exclusively under the influence of the pole nearest to them, whilst the opposite electric appearances are only found in the central section of the nerve which is perhaps not at all, or at least not by such weak currents, capable of excitement. Be this as it may, the fact is sufficient for our purpose, *that by the experimental arrangements which are possible for us, with a healthy person none but this normal formula appears, and that we are permitted to account every aberration therefrom a pathological phenomenon.*

Under pathological conditions, as may be seen by Brenner's and my observations yet to be mentioned, an An S reaction, and even the Ka O reaction are not very rarely obtained ; however, in physiological conditions with quite healthy acoustic nerves, this seems not to be the case. Truly now and then, even with An S a sensation of hearing was perceptible by me, but on a closer examination this appeared always to be a deception. I myself thought repeatedly that I perceived in my ear during the An D a quite weak, scarcely definable, and continuous sensation of hearing, but it disappeared completely, if I made the experiment without filling the ear with water.

Until now I have never succeeded, in spite of special attention directed to this point, with healthy persons in obtaining a distinct sensation of sound, even with proportionately high current-intensities with An S. I must, therefore, for the present, until further researches, consider the above stated normal formula as the correct one. With regard to the kind of sound sensations produced, they seem, according to my present experience, not to be very variable with healthy persons.

As a rule, a high metallic, more or less clear and pure, ringing is experienced, which is designated by most as a kind of whistling. I myself have had a sensation similar to subjective ringing in the ears, others compare the sound to a fine, very high-ringing table-bell. This depends, perhaps, on the fact that the anatomical situation of the nervous apparatus in question constitutes a favorable condition for the efficiency of side-currents.

Only in pathological conditions I have so far heard other sensations of sound described; high tones are regularly said to be much louder and more musical, besides there has been described to me a humming and buzzing as of bees, &c. I have always found the same sound with the same person; in pathological cases the sound with different current-intensities partook sometimes of a different character, it became with higher intensities clearer, with lower more dull. With the same person the first sensation of sound appears with nearly the same intensity of current; it is, of course, not possible to determine this exactly, on account of the different electro-motor power of the battery on different days on account of the changing condition of the electrodes, the skin, moistening liquids, &c. In high degrees of hyperæsthesia of the nervous apparatus of hearing, I have been convinced several times that the removal of An from the ear and carrying towards the chin, has the same effect as anode opening; ringing ensues, which is the louder the more rapidly this removal is accomplished, if one moves the An to the ear again, the ringing disappears; the effect, therefore, is the same as with An S. It is the reverse with Ka. Removing the latter from the ear makes the ringing which existed before disappear, approaching the Ka produces it again, the louder the more rapidly it is done, all exactly as Brenner has already described it. I do not doubt that all the phenomena which have been mentioned may be reduced to a direct excitement of the nervous apparatus of hearing by the galvanic current.

I am, therefore, entirely of Brenner's opinion, that here

the question is of a direct conducting and direct excitement of the nervous apparatus of hearing. I can not comprehend how people can return forever to the improbable hypothesis, that the sensation of hearing produced by the galvanic current depends upon reflex action from the trigeminus.

Leaving out of consideration that the existence of similar sensations, especially in the higher nerves of sense, is not yet at all fully understood by physiologists, it seems to me also that all the facts are against this voluntarily assumed hypothesis, so that I believe we must entirely dissent from it. On the other hand, the idea of the direct excitement is so perfectly congruous with all that we daily observe in the galvanic excitement of the nerves of the body, that I can not see why we should not prefer the simple explanation which agrees with all the facts, to an incomprehensible hypothesis. The reasons given by Brenner against the view of reflex excitement of the optic nerve, as also, upon p. 94 *et seq.* of his book, against reflex excitement of the acoustic nerve, seem to me quite sufficient to refute this view. Most striking seem to me the facts which show that with such a position of the electrodes as is unfavorable for the entrance of side-currents to the deeper parts of the nerve of hearing, while they are entirely favorable to the excitement of the trigeminus, the sensations of hearing decrease or disappear, while with such a position of the electrodes as favors the penetration of side-currents into the depth, the intensity being at the same time diminished, the sensations of hearing become more distinct and louder.

I have made a series of experiments hereto appertaining on a case of hyperæsthesia of the nerve of hearing (see below, Fuchs), and will communicate an abridgment of them here.

1st Series.—It is to be examined, what intensity of current is required in different positions of the second electrode for producing sensation of sound, while the first electrode remains fixed upon one point in the neighborhood of the ear. There always required 10 El, with a small button-shaped sponge electrode conducting the current through the mastoid process as well as through the region in front of the tragus, for the first sensation of sound.

The Ka now remained immovable in front of the tragus; then there is required for the obtaining of Ka S Kl,

With the An on the infra-orb. foramen of the same side,	12 El.
" An on the malar bone (1" from Ka),	16 El.
" An on the temple,	14 El.
" An on the lower jaw,	14 El.
" An on the mastoid process, same side,	20 El.
" An on the opposite shoulder,	14 El.

Thus with An on the opposite shoulder, sound appears with the same number of elements, as when upon the infra-orbital foramen of the same side; although in the latter case the resistance to conduction is much less, the pain and the excitement of the trigeminus is always greater. The same relations take place with Ka behind the ear; here likewise the greater intensities of current are required, the more favorable the position of the electrodes for a union of side-currents. The same condition obtains also for the An O reaction, if the An is placed near the ear.

2d Series.—It is to be proved, whether, with one and the same intensity of current, sensations of sound appear if electrode B is placed on different points.

In them, the button-shaped sponge ear-electrode is introduced, well moistened, into the meatus not filled with water; the tolerably large electrode B is placed at different points near by, and with 4 El simply Ka S made, with 2 El. Volt. Alt. used upon the Ka.

Left ear.	An on right cheek.	Right malar bone.	Left cheek.	Front of left ear.	Left proc. mastoid.
4 El. Ka S	Loud sound	Somewhat weaker.	Weaker.	Very weak	Nothing.
2 El. Volt. Alt.	Loud sound.	Weaker.	Very weak.	Nothing.	Nothing.

I need not add any thing to these experiments; they certainly speak decidedly for the opinion that it is the deeply entering influence of the current which gives rise to the sensation of hearing, and not the irritation of the trigeminus. It may also be concluded from them, that the sensation of sound is not produced by the directly irritating operation of the galvanic current, but that they as well as the subjective phenomena of roaring in the ear which appear, are the result of a heightened sensibility of the nerve of hearing. Aside from the many times very different quality of this roaring, and the generally high metallic character of the sensation perceived: aside from the fact that an increased sensibility to external sounds is not perceived in any noticeable degree—the normal formula obtained is not in accordance with the law ascertained by Pflüger, and can not be explained by it. The Ka sensation ought to increase in intensity during the Ka D, as the electrotonic excitement increases during the duration of the current (especially with relatively weak currents) the Ka O sensation ought to occur after the disappearance of the Katelectrotonus (after a nega-

tive modification of short duration) a very well defined positive modification of the nerve manifests itself.

It will, therefore, be more simple from these reasons to remain content with the direct excitement, which is in itself so perfectly in accordance with the facts found otherwise and established beyond doubt.

It is of but little satisfaction, after having convinced one's self by one's own trouble and labor of the correctness of scientific facts, to occupy one's self with the negative results of others on the same subject, and to ponder over the causes to which these failures may be attributed. After having satisfactorily convinced myself of the difficulty of galvanically exciting the ear, as well on myself as with numerous others; after having, nevertheless, become convinced that it is possible with some perseverance and skill to succeed even with healthy persons in most cases, I can not refrain from pronouncing my conviction in so far, that those who obtained negative results have either lacked the necessary patience and skill, or they have experimented after quite impracticable methods.

With continued practice and with the application of the manipulation repeatedly described, even those will succeed, if they are in earnest in the matter, in overcoming the continual failure of their experiments.

Schwartze's unfortunate experiments* have been explained by Brenner,† in his criticism in reply, in such a full and convincing manner, that it is superfluous to spend one

* Schwartze Ueber die sog. Electro-otiatrik Brenner's. Arch. f. Ohrenheilk. I.

† Brenner, Erwiderung. Virch. Arch. Band 31. S. 483.

word further on it. I can only recommend the impartial treatise of Brenner to the repeated perusal of all those who intend to occupy themselves in real earnest, and with scientific aim, with this interesting subject; it contains an unusual amount of instructive material. Even on the completely negative paper of Sycyanko,* who likewise denies the possibility of exciting the nervous apparatus of hearing by the galvanic current, I have nothing to add to that which Brenner has already said.† Moreover Bettelheim, of Vienna,‡ did not obtain satisfactory, although not quite negative, results: as no particular descriptions of method, current-intensity, &c., are given, we need not stop to discuss it.

As however Bettelheim, in his Thesis III., can not omit to throw suspicion on the teachings of Brenner, I refer to the work of Brenner above cited (Virch. Arch. B. 31. s. 510), where he explains himself more fully with regard to the reliability of the results obtained on deaf and hard-hearing persons; certainly the normal formula of Brenner has not been deduced from deaf persons and those hard of hearing. The most recent negative results, lastly, come from Schwanda, of Vienna.§ Although he has, in a supplement to his paper published in the *Oester. Jahrb.* (*l. c.*, p. 218), ex-

* Sycyanko, Ueber die Wirkung des Galv. Stroms auf das Gehörorgan. Deutch. Arch. für Klin. Med. B. iii. p. 601.

† Brenner: Z. Geschicte d. Reizg. d. Hörnerven, etc., ibid. Band. iv. S. 436.

‡ Bettelheim: Kurzes Resumé d. Ergbn. electro-otriatr. Studien, Wien. Med. Presse, 1868. No. 23.

§ Schwanda: Ueber die Wirkung der von der Holtz'schen Maschine gelieferten Spannungs Ströme am Menschen. Pogg. Annal. 133, §§ 622–655. Derselbe: Ueber die E. Maschine van Holtz und ihre Verwendung in der Electro-therapie Oester. Med. Jahrb. 24, §§ 168–218.

pressed himself with a certain confidence in opposition to the assertions of Benedict in such a way that the acoustic nerve of healthy individuals could not be excited to subjective sensations of hearing and to sounds, particularly not by the galvanic current, I can not omit declaring that his negative results are only attributable to his entirely faulty experimental arrangements.

From the treatise published in *Pogg. Anal.*, it may be seen that Schwanda places the one wire-shaped electrode in the meatus without filling it with salt water, and the second electrode upon the mastoid process of the same side.

That this is the worst possible arrangement, may, without regard to the simplest physical laws of the distribution of currents in conducting bodies, be inferred from the experimental results above-mentioned.

The intensity of current required to excite the nervous apparatus of hearing in healthy persons, is, with this position of the electrodes, in every case so considerable, that the pain is utterly unbearable, apart from the fact that the unavoidable muscular contraction would render impossible the fixation of the isolated electrode in the meatus. In reading that Schwanda in these experiments has perceived no facial contortion nor dizziness, it becomes perfectly evident that the experiments were made in a very unsatisfactory manner. They therefore prove simply nothing.

In my remarks on the secondary phenomena which occur on the excitement of the ear with the galvanic current, I need not occupy much time. They have been observed by me

exactly in the same manner as is so thoroughly described by Brenner. With one individual this, with another that, group of phenomena predominated, and likewise they varied in the different experiments. As far as I am aware there has not been any objection made to the correctness and exactitude of these more subordinate phenomena referred to by Brenner.

I will now proceed to the communication of some pathologic cases which have come to my notice in the *Ambulatorium* of the medical clinic of this place; they are neither numerous nor exhaustive, as I have made no efforts to obtain such cases, the object is only to show that changes of the normal formula happen with diseased ears, and may be proved with exactness and precision. I have not yet made any careful therapeutic experiments with the ear, but hope to occupy myself with it in the further progress of my experiments, as the results to be anticipated are of the highest theoretic importance for electro-therapeutics.

GALVANIC REACTION OF THE APPARATUS OF HEARING IN PATHOLOGICAL CONDITIONS.

I give here simply the cases so far observed, and shall accompany them with very few remarks.

1. *Simple hyperæsthesia of the left auditory nerve, with humming of the ear of some continuance.*

George Fuchs, 55 years old, day laborer, very intelligent, not hard of hearing, under galvanic treatment for disease probably central of the medulla oblongata. In the course of the treatment I

discovered accidentally the comparative excitability of the left nervous apparatus of hearing by the galvanic current, and was induced to examine the ears more carefully.

Right Ear.—Subjectively and objectively quite healthy, gives with 12–16 El the normal formula with great distinctness (see above, No. 8). The left ear, with which the patient says he has suffered for 4 or 5 years, shows materially different relations.

Left Ear.—Hearing distance for speech and watch somewhat diminished (for watch at a distance of 4 inches). The objective examination which Prof. Moos was so kind as to institute, shows slight hyperæmia over the handle of the malleus, which is pressed inward rather more strongly than normal. The concavity of the drum is increased, particularly in front; in the front and lower quarter, corresponding to the position of the light spot, a space about the size of a lentil depressed below the level of the surrounding membrane, in the neighborhood of which is a small shining spot (atrophy of the drum? cured perforation?). Patient, however, has never suffered from pain of the ear.

The examination with the galvanic current (internal arrangement, salt water in the meatus, B on the right hand) gives the primary excitability with 6 El, and there is deduced from it the following formula:—

6 El Ka S Kl, a high whistling.
— D Kl ∞, whistling, continuing till the opening of the chain.

— O —,	no sensation of sound.	The same formula appeared with unfailing certainty and precision with 8–12 Elem.
An. S —,	ditto.	
— D —,	ditto.	
— O Kl >,	sound remaining tolerably long.	

The continuation of the experiment gave the same formula quite unchanged, even with 4 El. With 2 El it was only changed in

this respect, that the Ka D Kl did not continue till the opening of the chain, but disappeared before it. With 1 El, however, even with Volt. Alt., it was no longer possible to obtain any sound sensation. I have repeated the experiment upon this man innumerable times, with various experimental arrangements, and always obtained, without exception, the same result. The rustling in the ear remained, during the several months of continuous treatment, almost completely absent.

2. *Simple hyperæsthesia of the auditory nerve on both sides. Constant noises in the ears; temporarily diminished by* An D.

Wm. Zimmerman, 62 years old, trackman, suffers from slight emphysema of the lungs with moderate dyspnœa; for several years has had some polyuria and a good deal of thirst; urine of a reddish-yellow color, clear, spec. grav. 1,010, contains neither albumen nor sugar. Patient complains, besides, of dizziness and confusion of head, and has a constant strong humming in his head which only seldom desists. He describes this as being like the roaring of a strong wind, not localized in one ear, but in the whole head, particularly noticeable, however, in the occipital region. His hearing is often interfered with by it. He has formerly suffered several times with a discharge from the ears. Intensity of hearing for watch diminished on both sides to 3–4 inches; for speech only slightly diminished. Bone conduction for a small watch present; right rather better than the left. Left drum somewhat cloudy, handle of malleus very prominent, light spot present, meatus normal. On the right side, with the exception of slight dimness of the drum, no abnormality.

23*d November*, 1868.—*Right Ear.*—Internal arrangement, warm salt water in the meatus, B on the left hand. 4 El Ka S —, 6 El Ka S —, An S —, An O —, then immediately 6 El Ka S: loud,

high whistling, which remains until Ka O; now, also, with An O Pf′. With 4, and even 2 El, the following formula is obtained:—

4 El Ka S Pf′
Ka D Pf ∞
— O —
An S —
— D —
— O Pf′ >

Even with two elements the whistling continues as long as Ka S is continued; patient, indeed, often thinks that it has disappeared, but when the chain is opened he says, "Now it is quite gone."

The accompanying phenomena are very slightly developed, pain only with 6 El Ka S, rather severe; during the continuance of the closing of the chain the patient hears (with both poles) an additional noise in the meatus, "like water boiling" (Electrolysis). I now tried to effect some influence on the noise in the head from the right ear.

The An is in the ear; 2 El, the humming continues.

An D — 4 El: humming becomes weaker; after 1 min. almost disappears.
—— 6 El: humming completely gone, after 1 min.
—— 8 El: completely disappeared; after *ca.* 10 sec. again.
—— 6 El: no humming after 20 sec.
—— 4 El: weak humming; after longer duration no humming.
—— 2 El: quite weak humming; after long duration no humming.

The chain was then slowly opened; no humming, head quite free and light.

Now the left ear is taken into the chain, experimental arrangement, mutatis mutandis, the same; 4 El Ka S —, 6 El Ka S —, An S —, An O —, then quickly 6 El Ka S: strong whistling; the

humming in the head returns, but somewhat weaker than before. An S: it becomes weaker; Ka S: it becomes stronger again. The formula of reaction is now first established; precisely the same relations show themselves as in the right side; with 6,—4,—2 El, the exact formula of Brenner for simple hyperæsthesia. The humming continues moderately after this experiment, and is now abolished in the following manner:—

An D 2 El: moderate humming.
—— 4 El: humming disappears after about 1 min.
—— 8 El: humming disappears " " "
—— 4 El: very weak humming which half disappears after 1 min.
—— 2 El: hardly a trace of humming: soon disappears.

After longer An D the chain is cautiously opened; no humming, patient feels uncommonly easy and free in the head. On the 27th November patient came again; after the first sitting the humming in the ears did not recur during the whole day; appeared again next morning; since then it is the same as before.

To-day the same experiment as at first, with external arrangement and with exactly the same results.

To-day also I succeeded, with An D and gradual withdrawing on both ears, in bringing the humming completely to an end. Patient has not returned for observation.

3. *Simple hyperæsthesia of the right auditory nerve. Hyperæsthesia of the auditory nerve, with inversion of the normal formula. Hard hearing in the right, complete deafness in the left ear. Strong humming for many years, especially on the left side. Temporary suspension of the same by* Ka D *to the left ear.*

Miss B—r, about sixty years old, has long been a sickly woman,

has been hard of hearing for many years, had formerly suffered often from discharge from the left ear.

Has had for about ten years continuous humming, which sometimes subsides, has loud rustling and noise in the head, especially on the left side, but sometimes also on the right side. The humming becomes particularly loud and troublesome at night when all is still; by day it is less loudly perceived.

Right Ear.—30*th December*, 1868.—Acuteness of hearing for speech very much diminished, only loud speaking is easily heard. Fine watch only heard by placing it upon the ear; bone conduction for this ear absent, membrana tympani with strong white dimness, in its anterior upper-quarter atrophied spot. Light spot normal, handle of the malleus visible, meatus normal.

External arrangement, without water in the meatus, B on the left hand.

4 El Ka S Pf′, very loud, distinct whistling.
— D Pf ∞, whistling continues till the opening.
— O —.
An S —.
— D —.
— O Pf $>$, very long-continued whistling.

Entirely the same formula is obtained with infallible certainty, with six and also with two El. With An S and D there is sometimes perceived a weak indefinable rustling, but it is not raised to a distinct sensation of sound even with a higher intensity of current.

It should be stated here that removing An from the ear towards the cheek, produces whistling, while the opposite motion makes it disappear again.

If we approach the Ka, which was before upon the cheek, to the

ear, a loud whistling is produced; by removing it, it disappe
again.

Left Ear.—Capacity of hearing with this ear completely extin as far as I could ascertain with the means at my command. Spe and watch were not perceived at all; no bone conduction. T membrana tympani is very much depressed, thickened, and w whitish opacity. Handle of malleus not distinctly visible; spot light present, but smaller than normal. In the hinder upper-quar a dark, much depressed spot, about the size of a lentil, over whi the adjoining part of the tympanum projected in folds (scar of perf ration). The valsalvian examination without result.

External arrangement, B on the left hand; the examination show here at once a complete inversion of the normal formula.

6 El Ka S —,	no sensation of sound.
Ka D —.	
Ka O Pf >,	weak, but long-continued whistling.
An S Pf,	very loud whistling.
An D Pf ∞,	continues till the opening of the chain.
An O —,	no sensation.

Accompanying phenomena very moderately developed.

Precisely the same formula may be, with all certainty, given w 8 and 4 El: with 2 El there only appears An S Pf, the reacti with Ka O is here wanting. By quick turning of Ka S with 6 I did not succeed to-day in obtaining any sensation of sound, i did I succeed on the 31st Dec., or the 2d and 5th Jan., 1869. it the formula given above was repeatedly established for b ears.

Upon the subjective humming the previous, chiefly diagnostic, ting had no influence worth naming.

On the 9th Jan., 1869, the effect of the current upon the humm in the ears was more carefully examined.

Patient had, in the beginning of the examination, continual loud humming, especially on left side.

The left ear is therefore first taken in the chain.

It first appears that the humming disappears with Ka S and Ka D, all is then silent, as no sensation of sound takes place; with Ka O, humming reappears.

With An S and An D it exists unchanged; besides the whistling produced by it, it has likewise disappeared after An O. Next slipping the electrode into An D was tried, with 2 El and 10 units of resistance on the Rheostat up to 8 El 1100 R; this succeeds without occasioning whistling; the humming goes on unchanged. Now quickly Volt. Alt. upon Ka S; then there arises distinct short whistling, the humming having disappeared. Then the intensity is brought up to 8 El and 1100 R, and then the electrode is slipped out to 2 E and 10 R; lastly the chain opened over the cheek by slow withdrawing of the ear electrode; all this succeeds without causing sensation of sound. The humming has disappeared, the head is quite free and light. Right ear taken within the chain. With Ka S upon this ear, the humming is not produced.

It is also here successive entering into Kn D, from 2 El 10 R up to 10 El 1100 R effected, which succeeds without sensation of sound. Then rapid turning upon An S. An D is retained pretty long and the electrode gradually withdrawn again without sensation of sound. Patient feels afterwards quite free and easy in his head. The humming did not return for several hours, but came back in the night in its former intensity. I will try, in spite of the unfavorable prognosis of the humming in this case, to treat him after the just-described method for a time; time will show with what success.

4. *Hyperæsthesia of both auditory nerves, with qualitative change of the normal formula.*

Franz Arnold, 54 years old, peasant, quite intelligent, and

capable of observation, comes to the clinic on account of dizziness in the head, which has lasted for several weeks; complains at the same time of a humming in the ears, of many years' duration, compared to deep buzzing, especially on the right side. Has formerly had running from the right ear.

With the right ear the watch is not heard at all, nor is there any conduction through the bones; speech of moderate loudness is only perceived quite near. Membrana tympani much dimmed, shows some atrophic spots, but no perforation. Light spot present. Handle of malleus not distinct. Left ear, watch heard at two feet, speech is distinctly perceived; bone conduction present. Tympanum pretty equally clouded; shows weak light spots.

Right Ear (external arrangement without water).—It is at once perceptible that the patient perceives two qualitatively different sensations as shown by the following formula: 8 El Ka S Bz, buzzing, humming pretty loud and strong, materially different from the buzzing which is produced by closing the meatus with the finger, or with water; it is produced likewise if Ka is on the mastoid process.

Ka D Br >, after some time disappearing.
Ka O Si >, a high, fine singing, metallic ringing, pretty long continued.
An S Si, very loud singing of similar quality.
An D Si, ringing continuing till opening.
An O Br >, the singing has disappeared; buzzing appears again; lasts pretty long.

Also, with Ka S, Ka D, and An O a humming; a coarse noise, as the patient calls it; on the contrary with Ka O, An S, and An D, a clear, fine singing, or ringing of metallic character.

The same formula exactly takes place, with infallible certainty, with 10 and 12 El, and then again with 6 and 4 El; with 2 El there only appears Ka S Br and An S Si.

Left Ear (the same arrangement without water).—Here somewhat different phenomena appear. Patient describes here likewise two different sensations which correspond to the different phases of the electric excitement; but these sensations may, by a change of current intensity, be merged one into the other, and brought to take place side by side.

For medium intensities (8 to 12 El) the following formula presents itself:—

10 El Ka S: Pf, high, loud singing or whistling.
Ka D: Pf >, gradually disappearing sound.
Ka O: Br, short humming noise.
An S: Br, very loud buzzing or humming.
An D: Br >, gradually disappearing sound.
An O: Pf >, whistling, as with Ka S, pretty long.

With 14 El a distinct Pf is perceptible at An S, together with Br.

14 El Ka S: Pf, very loud whistling.
— D: Pf >.
— O: Br, humming.
An S: Br Pf, humming and whistling at the same time, the latter shorter.
— D: Br >.
— O: Pf >, whistling.

With lower intensities Pf passes into Br with Ka S: likewise with An O.

6 El Ka S: Br Pf.
— D: Br >.
— O: br.
An S: Br.
— D: Br >.
— O: br.

With 4 elements there only appears Ka S br and An S bz, the first somewhat louder: these sensations may be made much more distinct by Volt. Alt. Patient makes always the same assertions with these relations in different experiments. He states also, that approaching one electrode to the skin of the ear has the same effect as the chain closing, removing of the same, the effect of chain opening. At the second examination, a few days afterwards exactly the same results were obtained.

5. *Qualitative change of formula with absent or only moderate hyperæsthesia.*

August Heller, 31 years old, house servant, had a running of the left ear, 8 years ago, pain, humming, for 14 days, which has happened several times; last time 3 years ago. The right ear he says has never been diseased. Nervous ear-humming never existed.

Right Ear.—(Prof. Moos.)—Low voice perceived at 8 paces, fine watch, 1 foot. Bone conduction preserved.

Deposit of lime on the anterior part of the tympanum; behind it, between handle of malleus and the deposit, an atrophy about the size of a lentil. Handle of malleus much depressed; the rest of the membrane quite cloudy.

Galvanic Examination.—External arrangement without water in the meatus.

12 El Ka S: Br = buzzing or humming as of a large bee, short and weak, but clearly distinguishable from the buzzing produced by simple closure of the meatus.

12 El Ka S: Pf Br >, at first short whistling, followed by longer, louder humming.

14 El Ka S: Pf >, loud and long-continued whistling; with this intensity of current the following formula presents itself:—

14 El Ka S Pf.
— D Pf. >.
— O —, no sensation of sound.
An S Br, very loud buzzing.
— D Br >.
— O Pf >, pretty long-continued whistling.

I did not succeed in changing the buzzing by An S with higher intensities (16 to 18 El) to whistling.

On the contrary, it changes Pf by Ka S, with lower intensity, to Br. With 8 El the above formula appears distinctly. With 6 El there appears with Ka S only Br, likewise with An S. With 4 El Volt. Alt. buzzing likewise arises with Ka S. The same relations entirely appear by repeated examinations with internal arrangement, water in meatus, &c.

Of course the required current intensities were different for producing the several sensations, but the quality of sensations remained always the same.

Left Ear.—(Objective examination by Prof. Moos.)—Perception of speech good; watch heard 1 foot, instead of 6; bone conduction preserved. Experiments with tuning-fork gave no definite result. Handle of malleus so strongly depressed that there could hardly be a doubt of the absence of the posterior part of the tympanum. Just in front of the malleus an oval scar of the tympanum; the remaining part of the membrane was thickened, gray, and only opposite the lower margin of the scar a small, strongly shining spot. With Valsalva's examination the lower half of the scar turns outward and changes in appearance, seems dimmer, while the upper half remains stationary, and the dark, shining look is preserved (adhesion in the cavity of the tympanum?). Galvanic examination (external arrangement without water in meatus). Here appear exactly the same relations; with Ka S, Br first appears, which

changes first to Pf and Br, and then to Pf alone, with higher intensities.

At the same time with Ka S Br appears An S Br, later the Pf with An O. Ka O gives no reaction; Br with An S can not be changed with higher intensities into Pf. With 6 El only Ka S Br and An S Br: 6 El Volt. Alt. Ka S Pf. With 4 El Volt. Alt. on both poles only buzzing. And these results were confirmed with different arrangements and repeated experiments.

Accompanying phenomena on both sides moderately developed; even with lowest intensities of current, facial contortions were present, following the ordinary law of contraction of the motor nerves.

Here I will add briefly the following case:—

6. *Low degree of simple hyperæsthesia (?) Former ear-disease.*

Junker, 34 years old, house servant, had a year ago a suppurative inflammation of the cavity of the tympanum, under treatment of Prof. Moos. After paracentesis performed on both sides, and scarifying of the artificial perforations, a simple non-suppurative catarrh of the middle ear with considerable diminution of hearing remained.

The affection appeared at that time during anti-syphilitic treatment, with extreme pain in the ear, and subjective sounds. Prof. Moos makes the following statement: for watch, 30 feet hearing-distance, distinct bone conduction on both sides; likewise for fine watch. Hearing distance for large watch, right side, 18 inches, left 22; for fine watch, both sides, 2 inches. After air injection, on the right side, 20; left, 24. Whispering perceptible on right side at 10; left, 8 paces. Right side hyperæmia of the inner part of meatus and of handle of malleus; this cloudiness of the whole tympanum especially on the periphery. Diminution of spot of light.

Left side meatus not hyperæmic, quite normal, membrana tympani and handle of malleus much depressed, posterior fold of the ympanum very strongly developed.

Galvanic examination (internal arrangement, meatus filled with ılt water, B on left hand). On the right ear was found primary ccitability.

With 8 elements the normal formula appears; patient hears ringıg as if one struck a fine bell.

10 El Ka S Kl,	loud ringing, sting pain, facial contortions.
— D Kl >.	
— O —.	
An S —,	pain pressing; less violent.
— D —.	
— O Kl,	weaker, shorter ringing.

Secondary Excitability.—With 6 El the full formula appears; ith 4 El, Ka S, reaction.

Tertiary Excitability.—After several turnings the full formula ppears distinctly; with 4 El An O Kl, but very weak. With 2 l Volt. Alt., distinct ringing still appears with Ka S.

Almost exactly the same phenomena appear on the left ear, ıly that here somewhat higher intensities are required to obtain ıe several sensations.

The obtainable formula, and also the quality of sound sensations ·e exactly the same as on the right side.

I have not much to add to the preceding observations. : is clear that they contain a series of confirmations of renner's observations, and to any thing further they do ɔt pretend.

I leave the pathological determination of these cases to ır-physicians. I must be satisfied to have shown the exist-

ence of anomalous reaction of the nervous apparatus hearing upon the galvanic current. In any case they a a new proof that by various diseases of the ear there m: be produced finer changes of the apparatus of hearing, well as anatomical changes, of which finer changes 1 former science of aural surgery has not even dreamt, a which it could not discover with the means of examinati which heretofore existed. It need hardly be mentioned th now, as Brenner has shown in a convincing manner, *tl examination of a diseased ear will only be complete whe the auditory nerve has also been examined by means of tl galvanic current.* After I have succeeded in the course ‹ a few weeks, in observing by mere accident quite a series ‹ pathologically reacting auditory nerves, it will surely not l difficult for aural surgeons to find numerous confirmation in their ambulatorium, of the assertion made above. would like to add a few words from the stand-point electro-therapeutics. It has not been possible until now examine and establish on the motor and sensitive nerve living man their reaction on the galvanic current in so p] cise a manner as on the nervous apparatus of hearii Much less has it been possible until now in the patholo cal conditions of those nerves to state with such certain their reaction with the galvanic current as is the case w: the nerve of hearing. Even the, in this respect, most « actly examined cases of traumatic and rheumatic paralys can not be compared with the pathological results in t auditory nerve.

The facts communicated above regarding the momentar

abolition of buzzing in the ears, offer such striking examples of the influence of the galvanic current upon the pathological state of the nerves, and are so clear and transparent in their effects as hitherto could not be stated with regard to the motor and sensitive nerves. Especially interesting appears to me the relation in Case 3, where, with inversion of the normal formula, the humming also was silenced, not as usual by An S, but by Ka S. The hope may be indulged that from such and similar observations, by degrees a more minute understanding of the therapeutic effects in certain nervous disease, especially in neuralgic and convulsive diseases may be developed, and that from this more minute understanding better methods of treatment may be discovered than we at present possess. I consider, therefore, the occupation with this most interesting subject as one of great promise, and can not too much recommend to every one who occupies himself with electric therapeutics, the acquisition by studies and experiments for himself the necessary practice and certainty in exciting the ear by the galvanic current, in order to obtain by this means new and fruitful facts for this branch of medicine.

With this I conclude the present communication. Nobody is more convinced than myself that the results are in many respects uncertainties and incomplete results. However little I have contributed I believe nevertheless, that I am able to be fully responsible for the facts here communicated. I know they contain nothing new, but are in all material respects only a confirmation of Brenner's assertions.

As it seems that his treatise is but slowly becoming known, I have hastened to contribute my mite, that in this highly important and interesting matter the truth may be recognized. I hope that this endeavor will be taken into consideration in criticising my paper, and wish others would follow my example, and not shrink from the difficulties of the subject, in order to examine it earnestly and minutely. I live in hope by means of this article to protect in the future the electro-otiatrics, as founded by Brenner, against the hasty and ill-considered criticisms of superficial observers.

HEIDELBERG, *January*, 1869.

INVESTIGATION ON THE RELATION BETWEEN THE HANDLE OF THE MALLEUS AND THE MEMBRANA TYMPANI.

By Prof. MOOS, M. D.*

Translated by T. R. Pooley, M. D., New York.

(See Table VIII, Figures 1 to 4.)

Since the publication of *Gerlach's*† classical research the literature of the histology of the membrana tympani has been interrupted by a long interval. Recently investigations upon this subject have again been made.

As the results of these investigations are partly contradictory, it seemed worth the labor to subject them to a new scrutiny, even should no other result be obtained than solving the contradictions.

We are indebted to *J. Gruber* and *Prussak* for more exact contributions on the present subject.

* The following investigations were made in the institution of my honored colleague, Prof. J. Arnold, to whom my thanks are due for his kind assistance.

† Microscopic Examination on the Human Membrana Tympani, p. 53, &c., in his Microscopical Studies. Erlangen, 1858.

Joseph Gruber* came to the following conclusions: "The short process and the greater part of the handle of the malleus are connected with the membrana tympani by a kind of joint, to which the handle of the malleus is only attached by its anterior and posterior margins, but aside from these attachments is free, while the short process of the malleus is surrounded by a concave articular surface situated in the membrana tympani. The articular cavity thus formed is filled with synovia. The fibres of the *membrana propria* have no attachment to the hammer, but unite with the cartilaginous formation mentioned. The short process has no real cartilaginous covering."

Prussak † asserts that the circular layer of fibres of the membrana tympani is so closely connected with the periosteum, respectively perichondrium of the hammer, that it can not be separated from them.

There can be no real cartilaginous covering of the short process, as half, and sometimes even two-thirds of the whole length of this short process consist of it. The short process shows in its axis large cells of cartilage, which towards the periphery become smaller and longer, and are transformed into the elongated corpuscles of the connective tissue of the membrana tympani. In the adult character-

* Contribution to the Anatomy of the Membrana Tympani. Wochenblatt der K. K. Gesellschaft der Aerzte, 1867, Nos. 1 & 2; also, Anatomy and Physiological Studies on the Membrana Tympani and Ossicula Auditus. Vienna, 1867.

† The Anatomical Relations between the Membrana Tympani and the Hammer. Medicin. Centralblatt, 1867, No. 15. Also, Anatomy of the Membrana Tympani. Answer to Dr. Joseph Gruber. Wochenblatt der K. K. Gesellschaft der Aerzte, 1867, No. 25; and Archiv für Ohrenheilkunde, vol. iii., p. 254, &c.

istic cells of cartilage exist in the interior of the osseous tissue of the handle of the hammer, the surface of which is covered by a similar more or less thick layer of small cartilaginous cells, equally transformed into corpuscles of connective tissue as the cartilaginous part of the short process. Prussak, and also Kessel,* deny the existence of a joint.

I. *Structure of the Handle, and its Relation to the Tympanic Membrane.*

Method of Examination.—Preparatory to the examination the membrana tympani of children was put, together with the hammer and the annulus cartilagineus, into a diluted solution of chromic acid for several days. Absolute alcohol, containing some hydrochloric acid, proved inappropriate, on account of swelling of the structure of the tympanum by imbibition.

The membrana tympani with the hammer in the adult was treated by Prussak's method; that is, was placed for two hours in a solution of one per cent. of chromic acid, with some drops of hydrochloric acid. (For infantile preparations one hour by this method is sufficient.) The preparation obtained with chromic acid was laid in absolute alcohol for twenty-four hours, and afterwards embedded in wax or paraffine. The following method finally proved the best: the membrana tympani is removed together with the annulus osseus, and cartilaginous, from the dead

* Kessel at the same place, p. 310, in his paper "On some anatomical conditions of the Middle Ear."

body, placed for two hours in a solution of one per cent. of chromic acid, containing besides some hydrochloric acid, then the preparation with the annulus osseus is embedded in wax or paraffine.

Then trials are made to cut the preparation, which each time is replaced into the chromic and hydrochloric acids, until fine sections are easily obtained.

In this manner the structure of the membrana tympani does not suffer at all, since it is sufficiently protected by the mass of paraffine. (The preparation, for instance, from which Fig. 4 is taken was obtained by this method.) Both transverse and longitudinal sections may be made in the easiest way after the described methods.

To obtain very demonstrative specimens, sections are placed for a day in absolute alcohol, stained with carmine after known rules, put in water for a short time, and afterwards again placed in absolute alcohol, after that put on the object-glass and covered with the slide until the alcohol is evaporated. In this way even the finest section assumes a certain degree of rigidity, which prevents the preparation from wrinkling or doubling up, when put into oil of cloves; the preparation is then preserved in either Dammar varnish or Canada balsam.

The sections were executed corresponding both to the longitudinal and transverse diameter of the handle of the malleus. By this method of examination we might expect to obtain conclusive results with regard to the arrangements of the parts and their component structural elements, as well as to the existence or absence of certain lacunæ. I

must expressly mention this, because Gruber (*l. c.* p. 63) asserts that the method of studying these conditions by making sections is insufficient:—

"On account of the minuteness of the parts, appropriate sections are difficult to make, and if connective tissue is accumulated in some portion, a discontinuity could not be demonstrated, although it might be seen in the neighboring portion. In some sections, however, we succeed, also, in demonstrating a discontinuity," &c.

After that he further (*ibidem*) says: "In my opinion, we get the best knowledge on the connection between the membrana tympani and the parts of the hammer, if we dissect cautiously the hammer from the membrana tympani. In this we see best where there are connections which must be detached, and where there are none. If the examination is conducted after this method, which in general is very easy, every one will be convinced that my assertions are true to nature."

The method employed by Gruber to decide the question whether there is a hole between the handle and membrana tympani is not in accordance with the principles generally adhered to by anatomists, *i. e.*, to make investigations only on such objects as have preserved their position as nearly as possible, or at least do not show any change of connection.

The application of the method above described shows the invalidity of the objection of Gruber, that the minuteness of the parts render the obtaining of appropriate sections difficult. On the contrary, the dissection of the handle out of

the membrana tympani, which, self-evidently, can not be performed without stretching the tissues and detaching some of their connections, will prove a very abundant source of possible errors in our judgment on the continuity or discontinuity of the parts. By the method last mentioned by me to obtain cuts through annulus osseus, cartilaginous, membrana tympani, and handle at the same time, stretches or ruptures are utterly impossible, because the parts are examined in the position which they keep during life.

Structure.—If we look under the microscope at a transverse section, obtained in this manner, of the membrana tympani and the handle, from a child 14 days of age, we see (Tab. VIII., Fig. 1), in the centre of the section, a mass of hyaline cartilage, which represents in the fœtus the cartilaginous malleus before its ossification (Koelliker).* The hammer consists for the greater part of singly nucleated round cartilaginous cells, which towards the periphery become gradually smaller, and more oval, with less distinct nuclei, so that in the peripheral layers formations appear which by their elongated and dense accumulation are distinguished at the first glance from the central ones. These spindle-shaped cells situated at the periphery are covered

* The progress of ossification of the handle during the first weeks after birth varies greatly. I saw, at least in transverse sections, taken from a child ten days of age, a considerable part of the manubrium already metamorphosed into bony substance, while a transverse section of the handle, taken from a child fourteen days old, showed bony substance only around a blood-vessel situated in its centre (Tab. VIII., Fig. 1). These differences in the commencement of ossification are perhaps dependent upon general conditions of nutrition.

by the cells of the perichondrium in such a way that an uninterrupted transition of both takes place. In this manner the union of the perichondrium, which itself lies beneath the mucous membrane, is effected, and it would be impossible to determine exactly the places in which the spindle-shaped cells cease and a layer of connective tissue of the perichondrium begins. *Hence it follows that between the perichondrium and cartilaginous tissue of which the handle consists, an intimate union takes place, but never a discontinuity or formation of lacunæ.* If we examine the relation existing between the mucous covering of the substantia propria, and the cutis layer of the membrana tympani, on one side, and the handle of the hammer on the other, we find that the mucous membrane stretches over the handle and is uninterruptedly connected with those parts of the substantia propria lying beneath it and surrounding the handle. Only the circular layer of the substance proper is in connection with the handle, and that in such a way that at the place of attachment of the circular layer to the handle of the malleus, the circular fibrous layer, together with the perichondrium, appear as one fibrous layer, the thickness of which gradually diminishes towards the mucous surface of the handle.

The relation between the perichondrium, respectively periosteum of the hammer, and the substantia propria therefore is as follows:—

The fibres of the perichondrium encircling the hammer like a ring, are continued at both sides into the fibres of the circular layer of the membrana tympani. At the

inner side of the periosteum, respectively perichondrium, we see the mucous covering which in both directions goes over into the mucous membrane of the membrana tympani.

Transverse sections of the membrana tympani in the adult show but immaterial differences from the conditions just described. (See Fig. 2).

Here also two layers of the substance of the handle may be distinguished in transverse sections, one situated in the centre, forming the greater part, consisting of bony substance,* and being traversed by very numerous vascular canals, the other situated at the periphery, being thin and going over without a sharp boundary into the membranous mass (periosteum) encompassing the handle. The union of the periosteum with the substantia propria of the membrana tympani is entirely as above described, *i. e.*, is so intimate that we may unhesitatingly consider the circular fibrous layer to be the periosteum of the handle as Prussak has done. Here too is the union between the mucous membrane, periosteum, and bone so close and uninterrupted that nowhere a discontinuity or lacunæ, but just as little the formation of a joint or synovial membrane takes place.

Good *longitudinal* sections through the handle and membrana tympani of the calf and man have, on exact examina-

* I am far from denying the correctness of Prussak's assertions, that in the adult the centre of the handle is provided with true cartilaginous nucleated cells, but I must say that I did not constantly find them in the adult; even missed them in some transverse sections of an individual 86 years of age. There seems to be some variety in this particular.

tion, shown the same results as the described transverse sections concerning the reciprocal relation of the handle and membrana tympani.

The parts situated at the periphery of the handle do not bear the stamp of ordinary hyaline cartilage; thence arises the question what kind of cartilaginous tissue there exists?

Prussak gives, indeed, a correct description of these parts, but does not determine the nature of their tissue. He says, (*l. c.*, p. 268): "Such elementary parts similar to cartilaginous cells are always observed over the whole periphery of the transverse section of the handle, but they are less characteristic.

"The true bony tissue gradually loses its peculiar structure towards the periphery, and its cells are replaced by others apparently resembling cartilaginous cells, the latter at the beginning are angular, oval, and finally become, towards the periphery, elongated. Some of them possess nuclei, others are devoid of them."

Prussak does not assert whether this layer, enclosed between the real bone and the periosteum, consists of true bone, osseous like, or cartilaginous substance.

My opinion is: that we have here neither to deal with cartilaginous nor bony substance, but with a transitory tissue, preceding the formation of bone, equivalent to cartilage.

Virchow,* from whom these expressions are taken, calls it osteoid tissue which takes its origin especially in the

* Morbid Tumors, Vol. i., pp. 463, 472, 530, and 535.

proliferating layers of the periosteum, and is encountered wherever the latter ossifies.*

II.—*Structure of the Short Process, and the relation of the latter to the Membrana Tympani.*

In the new-born, by far the greatest part of the short process consists of hyaline cartilage; with increasing growth a gradual metamorphosis of its centre into bony substance takes place. This, however, never reaches so far as to entitle us to assume, as Gruber does, a real cartilaginous covering of the short process; on the contrary, the layer of cartilage occupies in the adult, as Prussak justly remarks, a greater portion of its diameter than its centre, which is changed into bony substance.

A sharp separation between the short process, and the substance of the handle does not exist; the base of the short process is continued uninterruptedly in the substance of the handle of the hammer (see Tab. VIII., Fig. 3).

The condition of the cartilaginous tissue of the short process is essentially the same as in the cells of cartilage of the handle of the child; they undergo a gradual change, progressing from the centre towards the periphery into small spindle-shaped formations, which have already been described in speaking of the handle of the child, and are continued without interruption into the perichondrium, lying under the mucous membrane, with which, however, it is very intimately connected.

* The layers of the Annulus Cartilagineus, which are situated at the inner surface of the Annulus Tympanicus osseus, show quite the same condition.

Despite all my efforts I never could detect, neither in sections of the tympanum of children, nor in adults, a hollow articular surface filled with synovia, situated within the membrana tympani, and receiving the short process of the hammer.

Unfortunately I was not able to confirm another assertion of Gruber's, made in an appendix (*l. c.*, p. 63), *i. e.*, that he has observed fine epithelial cells on the inner surfaces of the cavities between the membrana tympani and the hammer above the short process.

The preparations from which Figs. 3 and 4 are taken did not, especially by applying a strong magnifying power, permit any doubt with regard to the negative result just mentioned. The absence of a joint, or a joint-like union between the tympanic membrane and the short process, is evident also beyond doubt from Fig. 3, although magnified only sixty times.

Résumé.

I. Between the periphery of the handle, and the tissue of the membrana tympani (substantia propria), both in the child and adult, a layer of tissue is constantly found, forming the intimate connection of both, and best called osteoid (Virchow).

II. The short process and membrana tympani also, are united through the interpolation of a continuous layer of osteoid tissue and perichondrium.

Explanation of the Figures to Plate VIII.

Fig. 1. Transverse section through the inferior third of the handle and membrana tympani of a child fourteen days of age.

a. External layers of the membrana tympani.

b. Mucous stratum prolonged at *c* over the handle of the hammer which is transversely cut. At the handle two layers are recognizable; a large central one and a slender peripheral one.

The former consisting of hyaline cartilage, and showing, at its upper end, the section of a vessel, the thin peripheral layer is composed of smaller spindle-shaped productions, and is continued into the perichondrium under the mucous membrane. Its union with the perichondrium also is dense, and in no place the circumference of the transversely cut handle displays a hole.

Fig. 2. Transverse section near the centre of the membrana tympani, and the handle of a man, æt. 26: *a*, external layers of the membrana tympani; *b*, mucous stratum continued at *c* on the hammer, which is transversely cut. Here also the transversely cut handle presents two layers, a central one composing the greater part of it, consisting of osseous tissue traversed by numerous vessels; and a thin peripheral one continued without a sharp boundary into the membranous mass (periosteum) surrounding the hammer. At the places of union between the handle of the hammer and membrana tympani, the parts of the substantia propria of the membrana tympani and the periosteum of the hammer are blended with each other.

Fig. 3. Transverse section through the handle of a still-born child of nine months; near the insertion of the short process the latter, *d*, is to a great extent cartilaginous, and seen as a triangular mass, the apex of which is directed towards the right in the figure, whilst its base is continued into the substance of the hammer.

The latter is already extensively ossified, traversed by numerous vascular canals, and has a large narrow space in its centre.

At the periphery there is a small zone of cartilaginous tissue, covered externally by layers of connective tissue, connected with the substance of the membrana tympani.

The mucous membrane of the drum surrounds the parts just mentioned, and is everywhere continued into the perichondrium.

The letters *a*, *b*, and *c*, have the same signification as in the previous figures.

Fig. 4. Section through annulus tympanicus osseus (*a*), a. t. cartilagineus (*b*), membrana tympani (*c*), and neck of the hammer (*d*) of a child nine months old and still-born.

Immediately above the short process, *e* corresponds to the outer surface of the membrana tympani, *f* to the inner, *g* and *h* to both the tympanic pouches transversely cut.

TWO FATAL CASES OF EAR DISEASE.

By Prof. MOOS.

Translated by J. H. Pooley, M. D.

ALTHOUGH the fatality of certain suppurative inflammations of the ear has long been known to aural surgeons who have kept pace with the progress of aural medicine, still the consideration of the first principles of medical practice, *i. e.*, to prevent disease, or at least to obviate the dangers of a disease already in progress, should encourage the specialist again and again, to call the attention of physicians to such cases, especially if, as in both those which follow, the manner of approach of the life-endangering disease is rare, or in the first case quite unsuspected.

CASE I.—*Apparently Latent Chronic Suppurative Inflammation of the Cavity of the Tympanum with Perforation of the Membrana Tympani. Constant Picking of the Ear, Opening in the Anterior Wall of the Bony Meatus, Parotitis, Pyæmia, Death.*

For the preparation to be described below, as well as the history of the case, I am indebted to the kindness of Dr. Dick, director of the Insane Asylum at Klingenmünster, as well as to the assistant physician, Dr. Löchner.

The preparation is from a woman forty-four years old, whose insanity took the form of nymphomania, with whom, on account of her disagreeable sensual propensities, it was hard to have any thing to do. While in the asylum she had never had any serious bodily ailment, nor had she since her residence there even suffered with running from the ear, or any observable hardness of hearing.

The only thing worthy of attention which had been noticed in her for a long time, was that she often put her hand to the right ear, and picked at it with a knitting-needle.

Nine days before her death an inflammatory swelling in the region of the right cheek was observed, and two days later a discharge of pus from the right ear, which was increased by pressure on the region of the cheek and lower jaw. The parotitis, the matter of which was discharged from the meatus, for which the disease was taken, was reated on ordinary principles; pyæmic phenomena, however, soon appeared, chills, flushes of heat, attacks of asphyxia, &c.; the swelling, which was very painful, spread downward even as far as the clavicle, and the patient died in consequence of absorption of matter, embolic processes in the organs of the chest, and violent fever, without any noticeable brain symptoms.

On the *autopsy* a large quantity of pus and dirty serum was found in the external meatus, which flowed out upon pressure over the region of the inferior maxilla. From the right ear, and the region of the temple, down the corresponding cheek and side of the neck as far as the second rib, and also upon the left side as far as the clavicle, there was a bluish discoloration and swelling of the integuments. The skin over these portions could easily be peeled off with the knife from the subjacent cellular tissue, which was reduced to necrotic shreds, infiltrated with pus and dirty serum. The gangrene extended as far as the sub-maxillary region, and included the cellular sheaths of the somewhat discolored muscles, but had not yet reached the lower parts of the neck. The parotid gland was partially disorganized, its lobules easily separable, and embedded in exudation. The jugular vein, the coats of which were unchanged, contained a very little dark fluid blood. Carotid artery normal. Under jaw and its articulation intact. (?) Inner surface of the calvarium, temporal bone, as well as the brain and its membranes intact. In both transverse sinuses dark fluid blood and some recent coagula.

Examination of Petrous Bone (Alcoholic Preparation, Tubes wanting).—The most striking appearance in the external meatus is an oval opening, about two lines long and one and a-half wide, with irregular margins, situated upon the inferior anterior wall at its inner end, quite close to the membrana tympani; the oval space is interrupted at one spot by a deficiency of substance, the membrana tympani is completely destroyed except its thickened margin; the margins of the perforation are smooth; in the upper part the margin of the drum is united by a small false membrane to the head of the stapes, and in consequence somewhat drawn inward; in the niche thus formed is found the head of the malleus deprived of its handle, and united with the carious body of the anvil. After removal of the latter the mobility of the stapes appears somewhat

impeded, but not completely abolished. "The cavity of the tympanum (Klingenmünster Post-Mortem Record) was filled with thick bloody matter."

The horizontal part of the mastoid cells, *antrum mastoideum*, strongly developed, and "filled with a thick grumous cheesy matter," which could still be seen to some extent in the alcoholic preparation. The cells in the perpendicular part of the mastoid process were but slightly developed.* Mucous membrane of the cavity of the tympanum thickened.

REMARKS.

If we take into consideration the changes described in the membrana tympani, the bones of the ear, the cavity of the drum, and the antrum mastoideum, there can be no doubt that the patient, although her physicians had not ob served any running of the ears or hardness of hearing, nevertheless, must have suffered for a long time from a latent suppurative inflammation of the middle ear; for the changes described, the thickened matter, &c., could not be the product of a disease which had commenced only nine days before.

It is, on the contrary, highly probable that the inflammation in the middle ear, although causing but slight discharge, had existed for a considerable time, and given rise to the constant manipulations of the patient in picking her ear, &c., which picking had become fatal to her. It may be surmised that, some time before the acute phenom-

* This condition of the mastoid cells is found pretty frequently in autopsies after long-continued suppurative imflammations of the middle ear, and is produced by chronic inflammation of the lining membrane of the cells of the mastoid process.

ena in the region of the parotid and maxillary articulation appeared, a mechanical injury had been inflicted by this constant picking to the soft and bony parts of the auditory canal, so that the transfer of the inflammation to the parotis took place, in the simplest manner, in consequence of a perforation of the wall of the auditory meatus. In the record of the dissection, it is stated that the lower jaw and its articulation were intact; I have, however, permitted myself to add a point of interrogation. For I consider it more probable in this case that the parotitis spread from the opening described through the maxillary articulation; as also the breaking through of the incisuræ Santoriniianæ the result of the parotitis, and not reversely the parotitis as consequent on the extension of an otitis externa through the incisuræ.

CASE II.—*Suppurative Catarrh of the Middle Ear on the Right Side after Measles. Union of the Perforated Drum with the Wall of the Labyrinth. Continuation of the Suppurative Inflammation on the other side of the Union. Formation of Polypi in the Middle Ear. Caries and Necrosis of the Petrous Bone. Death from Abscess in the Cerebellum.*

For the preparation described below, as well as the history of the case, I am indebted to the kindness of Prof. Von Dusch.

Theresa Schæfer, two years old, was attacked with measles five weeks ago. During convalescence had running from the right ear. Since that time the patient is said to have had convulsions three

times. Condition on her reception at the Children's Hospital at Heidelberg, on March 1st. Great emaciation: pale, faded complexion. Exanthematous papules in various places, numerous marks of scratching, probably in consequence of itching. Pulse irregular, now quick, now slow. Objective examination of the organs of the chest negative. Occasional slight cough. Appetite wanting. Stools hard, regular.

There is an offensive purulent discharge from the right ear. After her condition had remained unaltered for several days, with the exception of a slight improvement of the appetite, it was on March 10th as follows:—

The child cries a good deal at night, looks staring, pupils equal, reacting, belly large, doughy during sleep. The right half of the face contracted, right opening of the lids smaller than the left. No stool since yesterday. Running of the ear as before. In the evening, temp. 36.8 C. Morph. gr. $\frac{1}{12}$; iodide of potassium.

21*st.*—Lies in a quiet soporose condition since last evening. Strong contraction of the neck and the right arm. Eyes rolated downward and to the right, occasional convulsions of the right side. Swallowing difficult. Temperature in the morning 36.9.

22*d.*—Sopor continues. The child only notices on being roughly handled. On motion of the face the left half is seen to be incompletely paralyzed. Naso-labial fold effaced. Moves principally the right arm and leg. On attempting to move either the upper or lower extremities, they at once exhibit stretching and stiffness, the child may, therefore, be raised by the legs or head, trunk and limbs remaining stiff. Very strong contractions of the neck, when lying on the side complete opisthotonos; thumb of right hand drawn in. Urine passed involuntarily.

On the 20*th.*—Two hard stools. Pulse 120–116, irregular and small, hands cool. Respiration deep sighing, face alternately flushed and pale.

On the 21st.—Arm, hand, and face on the right side, for a considerable time, said to have been spotted, red, and hot; the left side, on the contrary, pale and cold. Right eye rotated downward and outward, left squints inward. Pupils moderately large, and reacting to right. Jaw firmly closed. Swallows only with great difficulty.

22d.—Temperature in the evening 36.6. Night quiet.

23d.—Stools and urine involuntary. Cheeks flushed, condition of the face same as yesterday. Left eye squints downward. Pupils react sluggishly, strong contraction of the right arm, thumb drawn in. Left arm powerless, with occasional slight tremor. Legs variably stiff. Belly large and hard. Pulse 156. Somewhat more intelligence. Swallowing a little better. Temperature in the evening 37.2.

24th.—Pretty quiet at night, takes more nourishment, is more intelligent, contraction of the neck and limbs less. Strabismus not so marked. Pulse 120–180. Temperature 37.1. No stool. Cries a good deal. Temperature in the evening 36.6. Up to the 30th her condition continued almost unchanged. Since the 30th formation of a fluctuating swelling on the right mastoid process.

On the 3d of April it was opened and discharged thick matter. Since the 9th April there has been again universal rigidity of the trunk and limbs. Paralysis of the face less distinct. Discharge from the wound diminished, running from the ear increased. After the soporose condition had again come on, with occasional board-like stiffness of the trunk and limbs, the reception of nourishment became more difficult, the emaciation extreme, and death ensued on the 22d of April, 1866.

Autopsy.—Body extremely emaciated, vivid discolorations on the surface of the belly and thighs. The inguinal glands hard and swollen. Behind the right ear a small wound covered with a scab. Dura mater distended, no coagulum in the superior longitudinal

sinus. A considerable quantity of clear fluid flows from the ventricles of the brain upon dividing the hypophysis; in various places, especially on the anterior lobes, there were several membranous adhesions. Brain and dura mater adherent to the petrous bone, between the base of which and the internal auditory canal matter welled up from the parts below; the adherent spot corresponds to the anterior margin of the lower surface of the right hemisphere of the cerebellum, which is softened. At this spot the os petrosum forms with the dura mater a part of the walls of an abscess about the size of a hazel nut, filled with creamy matter; the cavity of the abscess extends anteriorly towards the crura cerebelli and pons.

The wall of the abscess is smooth, and of a slate-grey color. In its vicinity the consistence of the brain is considerably diminished. Upon further examination the whole right hemisphere of the cerebellum seemed to be transformed into an abscess about the size of an egg, the walls of which, especially posteriorly, were so thinned, that upon removing it they gave way, and the contents flowed out. Most of the brain substance was here destroyed; in many places there is only a thin layer of brain substance remaining covered with pia mater. The inner surface of this abscess is also partly of a slate grey color, but partly also formed of the softened brain substance. The pus is of a highly offensive odor, and partly of a cheesy consistence. The quantity is about two ounces. No connection was found between the two abscesses. The ventricles were very much dilated, their membrane thickened, the brain substance in their vicinity of good consistence and only slightly macerated. The examination of the petrous bone showed in the external meatus a quantity of liquid matter, its membranous lining thickened; the cutis abraded of its epithelial covering, and reddened. Lower and anterior part of the membrana tympani completely wanting, for there is not even a vestige of the marginal portion visible; the remainder, reddened and thickened, together with the handle of the malleus, is drawn

backward and upward in such a manner that the upper portion of the cavity of the tympanum is almost completely separated from the anterior and lower portion.

The communication which may have formerly existed between the portions mentioned is completely obliterated by two globular growths (polypi of the tympanum) one of which is placed exactly below the arched margin of the tympanum which is drawn inward and upward, the other more anteriorly so that together with the swollen mucous membrane it left only a thin fissure through which one could see with a magnifying glass into the fenestra rotunda.

The mucous membrane of the Eustachian tube is unchanged; upon introducing a probe into it we pass through the remains of the cavity of the tympanum directly into the external meatus. Within the space formed by the union described above, is found the region of the stapes. The anvil is wanting. What space yet remains beyond the new formation is filled up with matter and cellular growths. On the petrous bone were found two communicating openings, about the size of a bean, irregular, with partially roughened margins, the one in the anterior wall of the cells of the mastoid process, the other on the posterior surface of the petrous bone, between its base and the internal meatus, exactly where the wall of one of the abcesses of the cerebellum was situated, and adherent to the bone by new-formed connective tissue. The carious opening in the mastoid process was partially covered by a loose piece of necrotic bone, a remnant of its former wall.

REMARKS.

The suppurative inflammation of the cavity of the tympanum following measles, led to the destruction of the anterior and lower portion of the membrana tympani; con-

trary to the general rule, not even its marginal portion remained; then followed the retraction of the remains of the membrane and its attachment to the promontory; the formation of connective tissue completed, as described, the separation of the anterior and lower part of the tympanic cavity from the posterior and upper one, and the patient was thus inevitably lost by the continuation of the suppurative inflammation in the posterior section of the middle ear. Evidently this unfavorable termination might have been avoided by timely and proper treatment before her reception into the Children's Hospital on March 1st. Under such circumstances the removal of the polypi in a similar case might become a vital indication; an indication to which I have first drawn attention, as far as I know, in my *Klinik der Ohrenkrankheiten*, p. 298.

TWO CASES OF EAR DISEASE IN COURT—DOUBTFUL RESPONSIBILITY.

BY PROFESSOR MOOS.

Translated by J. H. Pooley, M. D.

As is well known, the condition of the organs of the senses, especially of the eyes and ears, frequently demands the attention of the medical jurist. Generally the question to be determined is, whether an alleged disease of these organs really exists or not. Those cases are much rarer in which yet another question is to be decided, viz., whether a disease of the organs of sense is capable of exerting a disturbing influence upon the intellectual capacity of the sufferer. I have had the opportunity of observing and testifying in two cases of ear disease where this question was raised. Both cases appear to me important enough to be published. From the fact that in such cases it is necessary for the furtherance of the ends of justice to make a medical subject intelligible to laymen, my colleagues will excuse the popular manner of writing. As both cases offer

many analogies, we have, for the sake of brevity, avoided the repetition of many facts common to both.

CASE I.—*Trial of J. M. of G. for Perjury. Police Court B., July 9th*, 1867.

On being summoned, J. M. of G. appeared to-day, and the declaration upon oath of J. M. F. of R. was read to him (in which he is charged with giving false testimony under oath). After having been instructed of Sec. 200 of the Penal Code, he states: "For about three years I have not had such good use of my senses as formerly. I have almost lost my hearing and my memory; I have a daughter who has also been insane, and was taken first to Illenau, and is now in Pforzheim; I myself have had attacks of insanity, and have been treated by Dr. King now of R., and during the last attack by Professor Moos, of Heidelberg. During these two years I have been at times quite out of my mind."

Decree of the Grand Ducal Court of Heidelberg:—"This statement to be sent to Professor Moos, with the request that he will certify how far it is correct."

OPINION.

J. M. has consulted me three times for disease of the ear previous to my giving this written opinion, viz., 31st May, 13th June, and 10th July, 1867.

The examination of the patient gave the following result:—J. M., 66 years old, states that he has been quite deaf in the left ear for eight years: the hearing on the right has always been better than on the left, but has been failing for six months, with pain on this side. The acuteness of hearing varies at times, being worst in hot and rainy weather. J. M. states that two years ago he suffered for fifteen months with headache and dizziness, for which he was treated by Dr. K. (This statement was denied at his recent

examination). These complaints have improved during the last nine months, for about a year M. says he has had no sense or memory from one day to another; otherwise he has been healthy. When questioned as to the cause of his sufferings, M. states that in his thirteenth year he had a fall, was unconscious for four weeks, and it was under contemplation to trephine him. But since then he has heard very well. When asked whether he suffers from subjective sensations of hearing, he answers, "Not generally; occasionally, at night, the noise is like the ringing of bells." *Result of examination of organs of hearing.* Both external auditory canals large and dry. Right membrana tympani strongly concave, very much clouded, especially its periphery, spot of light perceptible, vessels of the malleus injected; behind the handle of the malleus there is an oval, cloudy spot, probably caused by the union of the long end of the anvil with the membrana tympani. The left drum presents the same general aspect, except that the general cloudiness, the dimness of the spot of light, and the cloudy margin, are still more marked; but the partial cloudiness behind the malleus, and the injection of the latter are wanting. *Nose and Fauces:* Mucous membrane of the fauces, especially the arch of the palate much reddened. M. suffers from great dryness of the throat, which is improved by gargling, likewise with a sensation of stoppage of the nose, for which he is often obliged to take a pinch of snuff at night. Upon the introduction of the catheter into the Eustachian tube on the right side, and on forcing air into the middle ear, there is produced by the motion of masses of mucus a rattling sound and a lively sensation of the entrance of air; the left side is less pervious to air and there is no rattling sound.

Hearing Distance. Right: loud talking, two paces; watch (of thirty feet hearing distance) only heard in contact with the ear. Left side, only a loud shouting in the ear is heard; watch not at all. It is heard when placed in contact with bones of the head, on both

sides; the tuning-fork in contact with the bones of the head is also heard, without his being able to state distinctly on what side it is loudest. The application of the catheter at the first as well as the following examinations, and gargling with alum which was prescribed, produced an improvement on the right side of from two to four paces; on the left the improvement was very trifling; the hearing on the left side remaining throughout almost annihilated.

Diagnosis. M. suffers with a double chronic catarrh of the nose, fauces, Eustachian tubes, and tympanic cavities, with considerable deficiency of hearing on the right side, and almost complete deafness on the left; but only occasionally, and then at night, from subjective sensations of hearing. The question then is, shall we believe his assertions? "I have no more sense or memory, not from one day to another;" and can we explain these phenomena from the disease of the ears. We frequently meet, in practice, with ear patients who suffer in a similar way to M., viz., with chronic catarrh of the middle ear, and that, too, in persons still young and full of life, and otherwise by no means nervous, who state without being asked: "Since I have had disease of the ears, I can not think well, my memory is weaker," &c. But these are usually cases in which the patients are troubled with violent subjective noises, or with head symptoms of other kinds, and this continually, but of this phenomenon M. only complains "sometimes and at night." I received, for instance, from a patient with continual violent subjective noises the following statement: "The humming becomes so strong that I can neither think

nor speak clearly." Another patient of mine suffered so violently that she repeatedly made attempts at suicide. In my *Klinik der Ohrenkrankheiten*, p. 187, I take the following statements as to this condition from those which are frequently noted in my histories of cases, "I am not the same in mind as I was, I ca nnot think, I am melancholy, I am often at the point of suicide, &c.," complaints which have been confirmed by other aural surgeons in similar cases, most recently by Dr. Kœppe, of Halle, in a paper on *Disturbances of Hearing and Intelligence* (Allgemeine Zeitschrift für Psychiatrie und psychisch gerichtlishe Medicin, Bd. xxiv, H. 122). Dr. Kœppe has proved that such subjective phenomena of hearing, by the illusions of sense to which they lead, conjoined of course with a special state of the brain, may occasion a real mental disease, and mentions cases in which by treatment of the ear disease the whole psychical disturbance has been removed. From all this it follows that the ear disease under which M. labors may possibly produce insanity, but that in him the subjective, long-continued, troublesome sensations of hearing and the peculiar changes of the brain which specially lead to it are wanting. If, then, we are willing to accept the existence of mental disturbance, &c., in M., we must do it on his own statement.

Have we now any other ground beside his ear disease in the examination of the patient from which we may with justice draw a conclusion as to his defect of mind, weakness of memory, &c.? M. is 66 years old. At this time of life there are developed peculiar processes of involution, as

atrophy of the brain from senile degenerations of the arterial system, apoplexies, softening of the brain, &c., conditions which may disturb the life of the brain and the mental condition of the person in a high degree; but these are always associated with other serious bodily ailments which I need not enumerate. But M. has stated: "I am otherwise healthy;" and, indeed, I have found him to be so at his repeated visits to my office, besides he has behaved himself rationally throughout, and remembers all the particulars of his sufferings.

Lastly, there remains one other fact to be taken into consideration: M. had in his 13th year a fall upon the head, and was then unconscious for four weeks, and came near being trephined. Now we know from the literature on this subject that injuries to the head, or mere concussions of the brain often lead, even after many years, to mental disease. This may occur in such a manner as to produce pathological disturbances in the contents of the cranium, or of the cranium itself, although no demonstrable lesions can be found. Griesinger says in his treatise on Mental Diseases that insanity may appear immediately, or after the lapse of years (even ten). Its development at a period long after the injury is the general rule.

The Vienna alienist Schlager has observed among 500 insane persons (see Zeitschr. Wien. Aerzte, 1857, and Griesinger *l. c.*), 49 in whom the psychical disturbance depended directly upon the consequences of previous concussion of the brain—42 men and 7 women: in 21 cases there had been complete unconsciousness; in 16, only want of memory, con-

fusion, &c.; in 12, only dull headache immediately after the injury; in 19 cases the psychical disease commenced in the course of one year after the injury, but in many other cases much later, in 4 cases after more than ten years. The patients exhibited from the time of the injury a tendency to congestion of the brain, upon drinking even a slight quantity of spirituous liquor, from trouble of mind, &c., and frequently hyperæsthesia of the eye (subjective appearances of light, color, &c.). In 15 cases there appeared a short time before, and during the continuation of the mental disturbance, black scotomata, which had a definite influence on the character of the delirium; 18 times hardness of hearing with frequent ringing and humming in the ears, and three times abnormal subjective sensations of smell, with alteration in the pupils, appeared. Very frequently a change in the disposition, and mental character of the injured were the precursors of real insanity. In 20 cases there was noticed irritability, angry outbursts of the wildest kind, less frequently self-conceit, tendency to dissipation, flightiness, and restlessness; in 14 cases weakness of memory, confusion, and attempts at suicide. Of all these symptoms we find in M. only hardness of hearing and weakness of memory. The first may be sufficiently explained by the aural disease, and the latter can not possibly be caused by injury of the head, especially concussion of the brain, which took place 53 years ago.

I believe no sober physician would venture the assertion that there could be such a case in which a lucid interval of 53 years had existed! As no definite questions had

been proposed to me for answer by the court, I confined myself to the simple statement that my examinations of M. hardly justified the conclusion that he is confused in his senses, weak in memory, or incapable of thinking.

The accused having escaped from justice, and not reappearing for examination, the court postponed his final trial till the time of his apprehension.

CASE II.—*Opinion on the state of health of E. B., of H., accused of Perjury.*

By decree of the Grand Ducal Court of Heidelberg. Dated June 25, 1868. No. 17,969. The following questions were proposed to me for answer:—

1st. Is E. B. hard of hearing and in what degree, and was she so in October of the previous year?

2d. Does hardness of hearing cause, and in what degree, weakness of memory, and has this been the case, and to what extent, with E. B.?

Ad. 1. E. B. has already been treated by me for a long time during the summer of 1867 for a chronic catarrhal inflammation of the middle ear, with continual subjective sensations of hearing. At that time the perception of speech was so much weakened that rapid conversation of any extent, without marked raising of the voice and accentuation of the words, could not be distinctly understood. From August of the previous year I did not see B. any more until she was sent to me by the Grand Ducal Court for examination.

The first examination was made on the 21st of June, 1868. E. B. is 67 years old; she says she has had pain in the ear for two years and a half; the suffering commenced with noises, and deafness gradually increased. The pain in the ear developed itself about the time

when a tile fell upon her head from a considerable height, in consequence of which she was confined to her bed for some days; medical assistance, however, was not called in. Since the beginning of her disease she suffers with pain in the forehead and vertex, and with a troublesome buzzing in the ears, which torments her night and day; she has also sometimes great dizziness; towards evening she is often beside herself; in short, she is unsound in the head. She was treated some time ago by the late Dr. V. for palpitation of the heart. The examination of the heart does not show any disease; the pa pitation was, therefore, probably nervous. The possibility must, however, be kept in mind, notwithstanding the want of definite signs of disease of the heart, of that peculiar fatty degeneration of the arterial system, common in persons of great age, which may easily occasion disturbance of the brain.

In addition she has now some disease of the eyes. She says she has never had catarrh of the nose or fauces, nor any other disease. As at this examination the external meatus on both sides appeared to be nearly filled with pretty hard masses, partly whitish, partly brownish, E. B. was directed to make use of the application of warm water for the purpose of dissolving and removing them, and requested to return for a further examination. The examination of the hearing gave the following results: Right side: short sentences in a loud voice understood at a distance of 4 paces, a watch, of 30 feet hearing-distance, heard only on direct contact with the ear. Left side: a sentence of 10 words spoken moderately loud, only 2 feet, the watch (according to her statement) only indistinctly. A tuning-fork, as well as a watch, placed on the bones of the head

are not perceived, a circumstance which at her age may be considered normal. June 28th the ears were syringed; from both, masses are discharged which consist partly of epidermic scales, partly of cerumen, and partly of fat which had been introduced by the patient for her relief.

The condition of the tympanum is as follows: right side, the whole membrane cloudy, its superficial layer loose, in consequence of which the handle of the malleus, which is slightly reddened, is indistinct, and the whole membrane flattened. Left side, the inner end of the meatus reddened, as is also the whole of the malleus, otherwise the appearances are the same as upon the right side. At an examination which was made a few days later, on the 1st July, it was found, as might have been expected, that the redness and sponginess were consequent upon the syringing, both drums now appeared cloudy, mostly upon their inner side, and especially on their margins, as they generally do in chronic inflammations of the cavity of the drum. Upon the introduction of the catheter and the injection of air into both Eustachian tubes, it passes into the cavity of the drum without causing any rattling noise. B. feels herself somewhat relieved by this manipulation on the left side, but on the right not at all. The hearing distance was afterwards about the same.

Now, from what form of ear disease is E. B. suffering? As the external auditory passages and the Eustachian tubes are free, the faculty of hearing still exists, but it is considerably diminished, and, as indicated by the changes described in the membrana tympani, we must, therefore, locate the seat of deafness in the tympanic cavity. We have here to do with an inflammation of the mucous membrane, especially in its connections with the joints of the auditory

bones on both sides, which has extended further upon the left side than upon the right, a disease by which the mobility of the ossicula is impaired in such a manner that vibrations of sound are only imperfectly conducted and received. But this change has still other effects upon the patient, especially on the left side. As the connections of the joints are pressed more closely together, the terminal end of the ossicula, the stapes, is continually pressed into the vestibule, and as the whole labyrinth is connected with the vestibule, the extremities of the auditory nerves are continually under the influence of pressure; hence the uninterrupted buzzing, just as we can produce subjective sensations of light even in darkness, if we press upon the globe of the eye, and so indirectly on the nerves of vision. Especially important are the phenomena of the effects of pressure upon the sides of the semicircular canals. Every mechanical injury of which, be it produced directly or proceed from the cavity of the tympanum, produces phenomena which we frequently at the bedside consider as nervous. Such are staggering gait, vomiting, and even unconsciousness. It has long been known to aural surgeons that pressure upon the external surface of the membrana tympani by plugs of exfoliated cutis, by means of ear-wax, by foreign bodies, *e. g.*, cotton, produces, in consequence of its influence on the vestibule, phenomena of pressure on the brain, shown by dizziness, staggering, indistinctness of vision, numb feeling on the corresponding side of the head, and occasionally also by moods of melancholy (Toynbee). This leads us to an answer to the 2d question:

Does hardness of hearing occasion weakness of memory, and to what extent, and has this been the case with the accused?

Those nervous phenomena of which we have just spoken are observed by aural surgeons in a much higher degree in diseases similar to that diagnosticated in E. B. And here we must take into consideration not only the pressure upon the brain, with its consequences, but also the fact that the disease has its seat in the cavity of the drum, which is very rich in nerves and stands in such manifold relations with other nerve fibres. Thus many patients state that since the increase of their ear disease they are not in their usual state of mind, that their memory is unreliable, and that mental labor wearies them much sooner than usual. Others again complain more of weakness of mind. Many become irritable, sad, ill-humored, melancholy, disposed to suicide; especially is this the case in those who are subject to violent subjective noises. Some become really diseased in mind, or insane. The layman will not find this so very incomprehensible if he places himself under the constant influence of an annoying external sound. How often we feel low-spirited under such circumstances, and for some time afterwards, even when we have rested, incapable of mental labor. How then must a patient feel who is obliged to be actively engaged under the annoyance of a constant violent noise in the head, so distressing that he can not find words to describe it.

The physician is involuntarily led to refer these phenomena to the disease of the ear, by observing how often such

apparently very serious nervous disturbances disappear after treatment which was directed to the ear disease alone. (Here follow remarks on Kœppe, &c., which, as they have already been given in the preceding case, need not here be repeated.) Remembering in the case of E. B. that she has added to the natural an artificial ear-disease by putting fat into the meatus, and that before the evaporation and drying up of the liquid portions of the grease, its contact with the walls of the auditory passage was more intimate, and the disturbance of functions still more considerable than at the time of the examination, we shall not assert too much, if, taking into consideration her want of education, we draw the following conclusions:—

1st. E. B. is hard of hearing in a high degree, and has been so since October, 1867.

2d. Hardness of hearing may produce weakness of memory; E. B. shows, leaving out of account her great age, weakness of memory, attributable to her ear disease.

3d. This weakness of memory may have existed at the time of the circumstances which involved E. B. in the accusation of perjury, but whether it really existed then I leave to the court to decide.

I remark in addition, that, at the repeated examinations, E. B. has never made the impression of simulating. She gives satisfactory explanations when she is able to do so. For instance, in the examination of the hearing power, with regard to her physical antecedents, the examination was more difficult. As to her general relations in life, from her youth up to the time of examination, she gave information

which showed conclusively that there was no particular weakness of memory in this direction. Lastly, we have yet one more circumstance to take into account, although it is not contained in the questions, if we wish to do justice to E. B. in every respect. E. B. states that the ear disease commenced about the time when a tile fell on her head from a considerable height, in consequence of which she was obliged to stay in bed for some days; medical advice not being called in.

The accident did not occasion any real injury of the head.* If there had been a physical disease caused by this injury, other disturbances would have developed themselves in the course of 2½ years, besides headache and ringing of the ears which, moreover, may very well be referred to the ear disease; states of excitement, hallucinations, disturbances of sensation, &c., which, however, we do not find to be the case. A real psychical disease we can not admit, but we must of course keep in view that we may have to deal with the prodomic state of such disease developing still later, and have to consider the phenomena presented by E. B. as precursors of a mental disease to which the injury gave the predisposition, and of which the ear disease and its reactions on the brain is the exciting cause. This, however, can only be decided by the further progress of the case.

The proceedings before a jury at Mannheim, which had been ordered for October 5th, were countermanded, as

* Even slight injuries of the head may occasion psychical disturbances, and *vice versa.*

E. B. had been taken to the Insane Asylum for mental disease a short time before.*

* In the summer of 1868 I exhibited to my auditors an ear patient who was healthy in every other respect. The disease was a chronic affection of the Eustachian tubes (marked peripheral depression of the otherwise very concave tympanum, &c.), with moderate disturbance of the acuteness of hearing, periodical buzzing of the ears appearing especially during attacks of cold or catarrh, headache, and such an irritable state of mind that he begged his wife to let him be alone, to remove the children, not to tell him any thing unpleasant, as "he was not good for any thing during these attacks." He was otherwise of a quiet character, an industrious workman, and of good repute. A purely local treatment relieved him of his, in a medico-legal point of view, important sufferings.

ON THE MEDICO-LEGAL SIGNIFICANCE OF ATROPHY OF THE TYMPANUM, PRODUCED BY HARDENED CERUMEN.

BY PROFESSOR MOOS.

Translated by J. H. Pooley, M. D.

THE long-continued presence of hardened ear-wax may prove injurious both to the walls of the meatus and the tympanum. *Toynbee* mentions certain preparations in his museum, in which, in consequence of hardened cerumen, the bony meatus was found to be very much enlarged; in other cases the bones had undergone a partial absorption; in one a portion of cerumen was found embedded in the cells of the mastoid process, into which it had made its way through an opening in the posterior wall of the meatus. In another case where the cerumen, by its pressure, had caused an ulcerated opening in the membrana tympani, a portion of it had found its way into the cavity of the tympanum.

Toynbee does not mention atrophy of the tympanum caused in this manner by pressure, the reality of which

can as little be doubted, from the concurrent observations of many others, as its inflammation from the pressure of these hardened masses. To be sure, this atrophy of the tympanum from hardened cerumen occurs but seldom. It occurs somewhat more frequently from long-continued closure of the Eustachian tube in consequence of unilateral pressure on the tympanum, sometimes also, as a spontaneous lesion of nutrition in the course of chronic non-suppurative catarrh of the middle ear. In the following case the diagnosis was of medico-legal importance:—

A man, sixty-eight years of age, had been accused of perjury on the following grounds. About a year before, a neighbor had bargained with him for the sale of a piece of land. The neighbor asserted that he had obtained the consent of the accused to part with the land for a certain sum of money. The defendant denied this, and affirmed on oath that he had not given his consent. Plaintiff afterwards brought witnesses who testified to having heard the defendant give his consent. Now the prosecution for perjury was instituted against the defendant. Defendant made objection, stating that he must insist on his former assertion made under oath. If he really had said yes, then he must have misunderstood the plaintiff, as he (defendant) had been hard of hearing long before the pretended sale, and was so at that time. The court committed the accused to me with the communication of the action, and the request to answer the following questions:—

1. Is defendant really, and in what degree hard of hearing?

2. Is it possible to state whether defendant has been hard of hearing for one year?

Upon examination I found both external auditory canals filled almost to the outer opening with black masses, which felt hard on being touched with the probe. It took almost a whole week to remove them by the use of dissolving remedies, and syringing with warm water. Before their removal his perception of speech extended only to the distance of two or three paces; the watch (of thirty feet hearing-distance) was only heard on pressing it against the ear, and by the bones of the head (corresponding to the age) not at all. After the removal of the hardened masses, his perception of speech was very good on both sides, and the watch was heard at a distance of several feet. The inner end of the meatus, and the circumference of the tympanum on both sides, together with the vessels of the malleus were much injected (effect of pressure and syringing). Behind the handle of the malleus, on the right side, was found a dark spot about the size of a lentil, depressed below the level of the surrounding membrane, at which, as was distinctly perceptible by simultaneously forcing air into the tympanum, the mucous membrane was forced up like a pouch, and at the same time was considerably injected, so that there could be no doubt that all the layers of the membrana tympani, even to the mucous membrane, were attenuated.

I affirmed the accused to be hard of hearing, stating, at the same time, that there could be no doubt it had existed at least a year. I inferred this as well from the hardness

of the mass, which of course was indicative of the duration of the affection, but especially from the atrophy which was discovered.

On this testimony the accused was immediately acquitted.

A SIMPLE EXPEDIENT FOR THE DIAGNOSIS OF ONE-SIDED SIMULATED DEAFNESS.

BY PROFESSOR MOOS.

Translated by J. H. Pooley, M. D.

IF we place a vibrating tuning-fork on the vertex, and close the external meatus on one side with the finger or a plug, as is well known, the tone will be heard more loudly on this side than with the open ear; with strong impressions of sound the tone becomes weaker. *Toynbee* and *Rinne* explain this phenomenon by the increased resonance of the external (closed) meatus; *Lucæ*, by increased pressure within the labyrinth; *Mach*, by the impeded egress from the labyrinth.

Politzer has made a series of experiments on this subject on the meatus of men and dogs, and on an enlarged artificial ear. (Archiv für Ohrenheilkunde, Bd. 1, H. 4.) From these experiments it follows that the increase of tone depends on increased resonance, produced by closure of the meatus, and on impeded egress of sound-waves from the ear. Politzer places the principal stress upon the impeded escape

of the vibrations transmitted through the air of the cavity of the tympanum and the mastoid process, while he ascribes only a subordinate influence to the impeded escape of the vibrations from the labyrinth. The decrease of the tone by tightly closing the meatus is dependent upon the extreme tension of the membrana tympani (Mach, Lucæ, Politzer), and also upon the increase of pressure in the labyrinth.

That the augmentation of the pressure in the labyrinth is not the cause of increase of tone, as Lucæ asserts, is demonstrative, according to Politzer, from the fact that it is not necessary to close the meatus, but only to narrow it, or substitute for it a little tube of paper, in order to effect an augmentation of the tone of the tuning-fork, in which case there is certainly no pressure brought to bear upon the interior.

The fact illustrated in this experiment, that the tone of the tuning-fork placed upon the vertex is heard loudest by the closed ear, forms the basis for the diagnosis of one-sided simulated deafness, a process which every physician, even if he is not a specialist, can make use of, in order to form an opinion as to whether he has a deceiver before him or not.

Let us first speak of the different eventualities which may happen in this examination. Some one asserts, for a certain reason, that he is deaf, or hard of hearing, on the right side, but hears perfectly well on the left.

The right meatus is examined and found free from disease. The left ear, on examination, is found to be perfect in its functions. The cause of deafness or hardness of hear-

ing on the right side can, therefore, to express it generally, only be looked for in disease of the middle or inner ear. In one-sided disease of the middle ear the tone of the tuning-fork, placed on the bones of the head, is heard, as a rule (for reasons mentioned above), on the diseased side only, or on this side the ground-tone, and upon the healthy side an overtone, or, as laymen often express it, they hear upon the diseased side a buzzing, and upon the healthy side a singing (Politzer).* In disease of the labyrinth the tone of the tuning-fork vibrating upon the bones of the head is not generally heard at all on the diseased side. As, however, persons suffering from real disease of the middle ear, sometimes assert that they do not hear the tuning fork at all on that side, we will wave this. Suppose the person to be examined is free from disease of the meatus, has good hearing with the left ear, and pretended deafness of the right ear, does not hear the tuning-fork vibrating on the bones of the head, and that the examination of the diseased ear by the mirror, catheter, &c., gives a negative result. I now close the healthy ear with a plug of charpie, and repeat the trial with the tuning-fork. If he now asserts that he does not hear the tuning-fork at all, not even upon the left (healthy) side, he is a malingerer beyond all doubt, if we have convinced ourselves by the functional examination of

* In order to exclude the overtones, either the staff-shaped tuning-fork of 256 vibrations, or a screw arrangement which is fastened on both ends of the tines of a prismatic tuning-fork, which gives higher tones, is to be used. Both plans originated with Politzer. The latter arrangement has not, as far as I know, as yet been described. I have seen it used by him, and it is the more worthy of recommendation, as the sounding of the tuning-fork continues much longer than is the case also with the simple prismatic tuning-fork.

the ear said to be healthy, that its function is really normal. or nearly so; most laymen think that one can not hear at all with the closed ear, not even from the bones of the head, and cases must frequently have occurred to every ear physician, in which patients with impaired hearing on one side attempt to close the healthy while the vibrating tuning-fork is placed upon the bones of the head, but leave the diseased one open, because they are under the impression that they are more likely to receive impressions of hearing during the examination with the unclosed ear, although it is diseased.

CASE I.—*Long Standing Disease of both Ears. Pretended beginning of Disease on the left side after a Blow on the Ear. Pretended Soundness of the Right Ear.*

F. Sitzler, a joiner's apprentice, fifteen years of age, received, ten weeks before my examination, a blow with the hand from his master in the region of his left ear. S. complains before the magistrate that in consequence of this he has become deaf on the left side, and suffers from a continual noise (in the ear). The legal physicians gave a negative opinion, *i. e.*, they declared that they could discover nothing. S. was now referred to me for examination, without the proposition of any special questions, but for a detailed opinion from a careful consideration of the circumstances.

The anamnesis and the physical examination gave the following result.

Duration of the Disease.—S. constantly affirms that he hears perfectly well now on the right side, and always has done so, but has been deaf on the left side for ten weeks, ever since, and immediately after, he had received three blows on the ear from his master. (According to the statement of the master it was only one.)

When questioned as to any variation in his power of hearing, S. affirms that he always hears equally well with the right ear, but with the left only when the roaring ceases, but after a time the roaring and buzzing begins again, and then his hearing is as bad as ever. *Pain?* Sometimes he has tearing pain beginning in the left ear, mounting up over the temple and forehead, and then his head becomes giddy and confused.

Cause of the Disease?—He alleges the blow upon the ear, immediately upon which the roaring and pain on the left side began. This roaring is as bad as the rumbling of a railway, comes on paroxysmally, lasts about half a day, ceases for an hour, then returns suddenly without any known cause.—*External meatus* on both sides without any noteworthy anomaly; upon firm pressure with the finger, S. says he hears no humming on the right side, but he does on the left (!). Right membrana tympani very cloudy, light spot obscured; strong peripheral marginal dimness, posterior fold of the tympanum very prominent, concavity increased. On the left these appearances were found still more strongly pronounced, vessels of the malleus, however, not injected. Mucous membrane of the nose and fauces reddened; mucous glands on the posterior wall of the fauces enlarged. Upon being asked, S. admits that for a whole year he has snuffled a good deal and been troubled with phlegm. With the nasal douche a great mass of inspissated mucus was removed, and S. admits that he feels very much relieved by this manipulation. Upon the application of the catheter, &c., the right ear appears easily pervious from the appearance of a rattling sound; in the left, on the contrary, the permeability is much diminished on account of great swelling of the Eustachian canal. S. says that this procedure feels better on the right than on the left. Testing the hearing distance, with blindfolded eyes (I consider this important where there is any suspicion of deceit) gave the following result. Right—whispering at seven paces, watch (of

thirty feet hearing-distance) at thirty-two inches, bone conduction present; on the left, according to his statement, loud spoken word heard only at two feet, the watch not at all. After the application of the catheter the examination of the hearing distance gave, with bandaged eyes, right side, watch forty-eight inches resp. ten paces, left five paces, for the watch nil. Upon placing the vibrating tuning-fork upon the bones of the head, S. says he has a humming in the head; upon a repetition of the question whether he hears any thing, S. says he hears a sound on the right side. Upon repeating the examination, the right ear being stuffed with charpie, S. says, and repeats emphatically, that he now hears nothing at all.

I omit here to repeat the testimony at length. Its important contents are as follows:—

S. has not only disease of the left ear but also of the right. This disease depends upon a chronic catarrh, which, if the statements of S. on the examination are to be trusted, has led to more considerable ill consequences on the left side than the right, as we frequently observe.

The result of the examination with the finger in the external meatus, and particularly with the tuning-fork, leaves no doubt in my mind that S. misrepresents the truth in the matter. Certain it is that S. has had disease of the ear before receiving the blow; how much this may have added to his previous disease is hard to say; for all S.'s troubles may be referred to the catarrh of the middle ear, even the pauses presented by the roaring in the ear may be explained by varying intumescence of the mucous membrane of the Eustachian tube. At the utmost we can only attribute to the blow on the ear the increase of an already existing dis-

ease. The military surgeon, Dr. *Chimani*, teacher of aural surgery at the Josephinum, in Vienna, makes use of the expedient here described, with very satisfactory results, in cases of malingering of soldiers (military simulation).—(Personally communicated.)

PECULIAR DISTURBANCES OF HEARING AFTER CEREBRO-SPINAL MENINGITIS. CONSIDERABLE IMPROVEMENT BY THE GALVANIC CURRENT.

BY PROF. MOOS.

Translated by H. Knapp.

THE case I am going to relate is of so manifold an interest that it is well worth a more detailed communication. The peculiar kind of disturbances of hearing is remarkable in a physiological point of view, and therapeutical success in the group of nervous affections of the ear is yet very rare, especially in auditory disturbances after cerebro-spinal meningitis.

John Herzog, æt. twenty-one, a robust farmer from Fuessenheim, near Lahar, felt quite well until Jan. 3, 1866, on which day he began thrashing in the morning at four o'clock. At seven and a half A. M. he had a chill, staggering gait, and drowsiness. Several hours later he felt better again, so that he resumed his occupation of thrashing. To combat the feeling of supposed weakness, he drank a small bottle of wine, which was followed by vomiting, severe headache, and great thirst. On the next morning his relatives observed his eyes to be staring, his limbs stiff, and his hearing hard. A physician ordered leeches and ice. Towards the evening his conscious-

ness returned, his hardness of hearing somewhat improved, but increased to complete deafness on the third day* of the disease.

The vomiting, constipation, stiffness of limbs, alternating with convulsions, squinting and unconsciousness ceased only on the ninth day. Four days later, he could hear the ticking of the clock, and eight weeks later the chimes of the church bells. In the beginning of his convalescence he understood ordinary conversation only by observing the movements of the lips. After a month he was able to understand words, when spoken directly into his left ear. Gradually his hearing improved of itself, to the capability of understanding conversation at from one to two feet distance. For about a year he could not notice any further spontaneous improvement.

The right ear was completely deaf from the time of the disease, until the examination. Several physicians treated his aural affection by the application of leeches, blisters, cups to the neck, instillations of different substances into the auditory canal; finally Dr. Schmidt, at Lahr, employed the catheter, inflation of air, water, vapors, &c., into the middle ear, but without any result, as he kindly communicated to me. Since the return of consciousness the patient suffers from severe tinnitus in both ears, which, on the right side, are continuous, extremely loud, and similar to the noise of a boiler; on the left, however, it abated with the gradual improvement of hearing, but is still present, resembling an uninterrupted ringing, and is allayed only very seldom.

Headache and vertigo, formerly very severe, are now, likewise, inconsiderable. On the other hand, the patient suffers from unsteadiness in walking, which is especially marked in the night, but sometimes, also, in the day. In the morning, immediately after rising, the giddiness is greatest.

* In the cases terminating favorably, reported by Ziemssen & Hess (Deutsches Arch. für Klin. Med., 1, 1, 3, 4, 1865), the hardness of hearing began mostly on the third day.

He thinks that he hears nothing at all with the right ear (which fact is confirmed by the subsequent examination), but only with the left, with which he hears very distinctly both his own steps and the lowest noises.

He asserts that he is able to hear the sound of a railway train in motion a long time before it can be seen. He says that he has heard the noise more than fifteen minutes before the arrival of the train. Moreover, the creaking of the pen with which I wrote down the history of his disease is quite distinctly heard.

He hears a watch, of thirty feet hearing-distance, at twenty feet, and another of six feet hearing-distance at three feet. He hears it, likewise, from the temples and the forehead, and a tuning-fork from the bones of the skull; but all this only on the left side.

By applying the double otoscope* of Mach, I could distinctly hear, myself, on both sides, the sound of an oscillating tuning-fork, which was put on the patient's forehead.

He could understand, however, only at two feet distant, my rather sonorous voice in a very small room.

From the third story of a house he could hear the steps of people passing over the street. On the left side he was deaf for the deeper sounds of the musical scale, a fact which was also confirmed by Prof. Helmholtz, who had the kindness to examine the patient (on the 10th Nov., 1867). Patient could not hear the twelve deepest tones of a piano with seven octaves (including the *mi* of the great octave). On the right side he was, as already said, completely deaf.

The right membrana tympani was very concave, dark, the bright spot reduced; the margin opaque; the vessels of the handle injected.

* I can not too highly recommend this simple instrument for the purpose of a differential diagnosis between affections of the labyrinth and the drum. By this means I heard quite distinctly the sound of a tuning-fork which was placed on the forehead of a patient completely deaf in both ears from an injury for eighteen years.

Valsalva's experiment succeeds on both sides, but is only felt on the left. No râles can be heard on auscultation of the middle ear during inflation, but the noise from the impulse of air on both tympanic membranes is very distinctly heard. This operation, however, had no influence whatever on the degree of auditory acuteness.

I now proceeded to examine the patient by the constant current.

I must mention that this was one of the earliest cases in which I applied the constant current, my arrangements at that time being very imperfect for electro-otiatric purposes.

My having yet little skill in its application on ear patients may, perhaps, be the principal reason for my not obtaining so definite a result with regard to the diagnosis of the case, as might have been expected from the history of the disease.

I am the more confirmed in this opinion by the fact that I obtained, as the following communication will show, different results, when several months later I treated the patient in a systematic manner with more skill and experience, but, also, with improved apparatus (Siemens-Halske's Modified Elements, after Brenner's design). The results arrived at in the first sitting (July 13, 1860) are the following: On the right side I did not succeed in obtaining a reaction of the kathode by applying from 1–15 Meidinger's elements, neither at the closing nor during the action of the current.

I did not venture to use more elements;* on the other hand the noise became weaker at the anode enclosing a chain of only eight elements, but did not diminish further, the number of elements was raised to fifteen, so that I diminished it gradually.

The result was, that during the action of the anode, the noise became weaker on the right side, but was more strongly felt on the

* The pain was too great. One electrode was in the external auditory canal in the hand of the same side; the external meatus was filled with water, &c. Internal arrangement of the experiment according to Erb.

left. After the opening of the anode the noise became louder again on the right side, and remained on the left as before.

The functions of the right ear were neither changed nor improved in any way.

On the left side I did not succeed either,* in obtaining a reaction of the kathode, but during the action of the anode up to four elements, the noise diminished so much that the patient said it had not been so feeble for some time; at the anode, however, the former condition returned.

On examination of the functions the voice now was distinctly understood at six paces, and a watch heard at six feet; before the application, two paces, three feet respectively.

I now encouraged the patient to submit to a methodical treatment. He, however, wished to do this after the harvest. On the 4th of Nov., 1867, I saw him again for the first time. The improvement on the left side, after the first application of the current, and the unfortunate condition of the right side, had remained stationary. On the right side I now obtained with eighteen Siemens-Halske's elements, and 250 resistances of conduction on the rheostat forming a secondary closing, a very distinct reaction of the kathode like a loud hissing, which also persisted during the action of the kathode; but I succeeded in no manner in gaining a considerable *persistent* influence on the subjective noises of this side, nor was the function materially improved; *temporarily* the anode produced a diminution of the subjective noises.

On the left side the character of the noise was changed with 11 elements and 160 resistances of conduction. He hears, apart from his ringing, a loud hissing, which continues during the action of the kathode; on changing to the anode both noises disappear, and gradually interrupting the chain, the noise remains absent for several minutes after the opening of the anode, and then returns. Sudden

* Here, also, the pain was very great.

opening of the anode was followed by immediate return of the usual subjective noises on both sides. We had, therefore, to deal with a case of hyperæsthesia of the acoustic nerve after Brenner.

I now treated, until the 28th of November, especially the left ear by gradual closing of the anode, until the noise disappeared, after which I gradually interrupted the chain by means of a stopper-rheostat, forming a secondary closing.*

The following observation is remarkable in this experiment. The patient constantly asserted that the noise (during the entering the anode), receded gradually from the ear into the occiput, where it slowly disappeared. He even indicated with his finger† the direction of the receding noise, tracing it from the ear to the occiput.‡ During this the subjective noise on the right side became constantly louder, or, as the patient expressed himself, "the noise was thrown entirely on the right side."

After four sittings the hearing power for speech was raised to 15 paces. Examination in two spacious adjoining rooms. After 22 sittings it only amounted to 18 paces, and the subjective noises on this side were much diminished, and showed greater remissions; other head symptoms were no longer present, and the unsteadiness was much less, so that the patient ceased treatment on the 26th of November, content with the result obtained; which, on the whole, may be called unsatisfactory, but rather favorable in consideration of the condition at the beginning of the treatment.

* Dr. Brenner, during his visit to Heidelberg, in the summer of 1867, was so kind as to make me acquainted with the application of this instrument by his method, for which I tender him my thanks.

† For quite a similar observation, see Brenner's Electro-Therapeutics.

‡ I have made the same observation in another case of deafness after Meningitis, in which I succeeded by means of the constant current in allaying the subjective troubles of the patient, but in no way to improve the function, the patient has remained totally deaf on both sides.

REMARKS.

No unprejudiced observer will doubt that the disease just described was a case of cerebro-spinal meningitis; the early symptoms and the acute course of the disease, especially the unconsciousness which suddenly set in and lasted for some length of time. Moreover, the rigidity of the limbs, convulsions, the condition of the eyeballs, the vomiting, &c., in a previously healthy and robust man of 21 years of age, who, after the disease, complained of no other symptoms but deafness, subjective noises, and vacillating gait, sufficiently confirm the diagnosis. Since the same disease, according to the testimony of his family physician, was very frequent in that neighborhood, the case was one of epidemic cerebro-spinal meningitis.

To do justice to my own researches, I must express my firm conviction that the deafness in this case was the consequence of a meningitis.

Voltolini indeed doubts (Monastschrift für Ohrenheilkunde, Year 1, No. 1; Year 2, No. 9) that the form of deafness which I have described as resulting from meningitis (Klinik der Ohrenkrankheiten, p. 322, &c.), is really dependent upon meningitic processes. He considers such cases to be acute idiopathic inflammations of the membranous labyrinth. In the next number of these "Archives" I shall make some remarks on Voltolini's reasoning, and his diagnosis of such forms of deafness.

The annihilation of hearing was rapid and complete; the function only returned slowly on the left side, first with the

perception of tones and noises (after four weeks), whilst the understanding of speech, even in the vicinity, returned only after double that time. If we appreciate the results of the tuning-fork, obtained with and without the double otoscope of Mach, in conjunction with other functional examinations, the integrity of the mechanism of the auditory apparatus becomes evident. The changes described in the membrana tympani have no considerable diagnostic value (the less so, as many remedies had been a long time employed in the outer and inner ear); had these changes really been evidences of an affection of the tympanic cavity, the high degree of the disturbance of function would have rendered it impossible for me to hear distinctly on both sides, by means of the double otoscope, the sound of the tuning-fork placed on the patient's skull.

It must, therefore, have been a nervous affection of the auditory apparatus.

I abstain from expressing my opinion which special region of the ear was the seat of the disease, since it will always be a supposition only whether the nerve was affected at its origin, in its course, or its termination; but this much we may assume with certainty, that a heterogeneous affection took place in nervous regions of different physiological action, because before the treatment a nearly opposite degree of hearing-acuteness existed with regard to the perception of noises and the understanding of speech. The deafness for deep sounds is less remarkable since it is often met with in cases of ear disease in general.

Far more interesting, and practically much more import-

ant, is the therapeutic effect of the galvanic current. After all therapeutic agents which have been recommended in aural surgery up to this day had failed, and the disturbance of function remained unchanged for one year and a half. one application of a rather imperfect apparatus to the auditory nerve for diagnostic purposes produced a considerable improvement of hearing, which by further treatment still increased.

ON RETINITIS LEUCÆMICA (LIEBREICH).

By Dr. OTTO BECKER, Professor in Heidelberg.

Translated by J. H. and T. R. Pooley, M. D., of New York.

In the year 1861 *Liebreich* described a condition of the retina discoverable by the Ophthalmoscope (Deutsche Klinik, No. 50), which he considered as the evidence of an inflammation of this membrane caused by leucæmia, and therefore gave it the name of Retinitis Leucæmica.

He had at that time observed three such cases. In 1863 he gave a representation of the previously described condition in Pl. X. of his Atlas, and says in the accompanying text that he has since then seen three other cases, making six in all. Both communications seem to have excited very little attention on the part of his colleagues or of pathologists. I conclude from this that some of them completely ignore these statements, although they have since then appeared in a new edition of his manual, others only refer to them with more or less reserve, while the otherwise so rich literature of recent years does not contain a single confirma-

tory observation. This appears the more strange to me, as I had myself, in 1866, the opportunity to observe two such cases in quick succession.

In the one case I had the right eye drawn at two different times by Dr. Heitzman, and I exhibited the drawings to the Ophthalmological Congress at Heidelberg in 1868, for the purpose of bringing this interesting subject into discussion. I regret that only Prof. Knapp was inclined to express his opinion, and he stated that he even, during the last summer, had had the opportunity of examining two exquisite cases of retinitis leucæmica, without finding either functional or ophthalmological abnormities of a remarkable character (see Sitzungsbericht der Ophthalmologischen Gesellschaft, 1868, p. 355). This indifferent demeanor of the members prompted me to recur to this subject anew and with greater minuteness.

The willingness with which the publishers and editors of this journal have undertaken to reproduce a number of ophthalmological pictures, in chromo-lithograph, is the reason why I have preferred this journal for my publication.* Of the two cases referred to, and observed by me, one was in the clinic of Prof. Arlt, of Vienna, in the winter of 1866–7, while the other came under my observation in the clinic of Prof. Oppolzer. The latter, P. W., a woman about thirty years old, had formerly been treated for chlorosis (anæmia), and later had been received into the clinic for a considerable enlargement of the spleen, and enormous multiplication of

* The author had to solve a previous engagement, already announced, with another periodical.—Ed.

the white corpuscles. Particular data concerning the history of the disease, wanting. I was led to examine her eyes, only because I had found, in the case soon to be described, changes in the retina, which Liebreich has called retinitis leucæmica. The patient had never complained of impairment of vision, nor was any found on examination. The fundus of the eye had nevertheless a very striking, quite peculiar orange-yellow color, which was very conspicuous even with the common gaslight used in the clinic ; but more especially when examined with daylight entering through an opening in a shutter into a dark room. As in general for all differences of color in the fundus of the eye, the examination with dispersed daylight was of the greater advantage in this case.

Whilst by using daylight the color of the normal fundus loses completely the mixture of yellow, which it receives from the flame of oil or gas, so that it approaches to a pure red ; in cases of leucæmic retinitis the orange remains, and only comes out more distinctly. In our representation, taken from the other case, this peculiar coloring is not exhibited strongly enough, because the original was printed by gaslight instead of daylight.

Equally characteristic were the shades of color of the arteries and veins, as it is generally in the fundus of the eyes colored by the blood circulating in the vessels of the choroid. The veins besides being uncommonly large and tortuous, and of indistinct contour, showed a bluish red approaching to rose, strikingly different from the dark-brown, nearly black-red tint which large tortuous veins

exhibit, for instance, in disease of the optic nerve, glaucoma, &c.

The arteries, on the contrary, proportionately narrow and pale-yellow, with scarcely any admixture of red. There was still another important change in the appearance of the retina besides these changes of color to which I refer more at large below.

The veins most changed were bordered on both sides by a small whitish margin which gave them a peculiar ribbon-like appearance. I had only a few opportunities of examining the patient, and can not, therefore, give any description of the course of the disease.

The first case which was treated for some weeks at the clinic of Prof. Arlt, I was enabled to examine more closely, for reasons to be stated below. I may be justified in describing this case with more minuteness.

John Meldschock, thirty-two years old, officer of the Royal Hungarian Council, from Waag-Neustadt, was received November 26th, 1866, at the eye clinic. In his eighteenth year, fourteen years ago, he suffered for a long time with intermittent fever. Since then it is supposed that his spleen and liver have been enlarged.

In the year 1860, he says he had a chancre at Commorn for the first time; in 1861, he suffered a second infection at Trentschin; since then he has twice had primary ulcers on the genitals. Nor were the secondary symptoms absent. Nevertheless he considered himself healthy till December, 1864. Since that time he complains of great general weakness, which appears at times and disappears, he has also

stitches in the left side, at the same time offensive ulcers on the right calf and fundament.

In January, 1865, there appeared suddenly severe pain in the chest; his physician treated him for pleuritis. After a fortnight he was able to leave his bed, but since then he has not felt well, and through the whole summer so weak that he could hardly walk. First the left leg swelled, then the right, likewise the wrist, elbow, and knee. But the separate attacks only lasted for a short time. In September he was attacked with an inflammation of the throat, and had a swelling in the fauces which did not break. One month later the right eye became diseased, but was restored by the treatment of his physician, who treated his disease as a catarrh. In November, 1865, the left eye inflamed and was very painful. Dr. Rydel was called and diagnosticated iritis, which he, on account of the numerous symptoms of secondary infection, regarded as syphilitic.

For this reason inunctions were instituted; twenty-four inunctions of ʒss each; after the twelfth inunction (on account of commencing salivation) he took iodide of potassium internally.

From the beginning of September he took daily one scruple of iodide of potassium; the iritis disappeared, and the patient felt comparatively well, and he was discharged Jan. 20th, 1866. At the end of February he became sick again, the symptoms were night-sweats, dizziness, vomiting, diarrhœa. Therapy: tannin, good nourishment, iodide of potassium.

A few days later there appeared facial paralysis on the

left side. Dr. Benedict declared the paralysis to be peripheral (?), and would not use electricity, but ordered iodide of potassium. The paralysis disappeared slowly in the course of months. During the whole time he had, towards evening, pains in his hands and arms, and at night violent headache.

At the beginning of June he was sent to Hall, where, after the fifth bath, pains of the bones appeared anew, without swelling however. Inunction was now tried again; after three inunctions salivation appeared, so that after the sixth inunction iodine baths and iodide of potassium were used again.

After the second inunction iritis reappeared in the left eye, but disappeared again after the use of atropine. The patient, on the whole, felt better after his return from Hall, he only suffered from a continual diarrhœa. About the middle of September he returned to his bureau, but was obliged to leave off duty, as the weakness increased so much that he could only walk a few steps with effort and could hardly write.

From time to time there came on, without special cause, attacks of violent vomiting or diarrhœa. His physician discontinued all medicine and tried to nourish him well.

Thus his condition remained, now better, now worse, till the 20th Nov., when he suddenly noticed in the evening that there was a thick veil or film before the left eye. This occasioned him to apply to the eye clinic; at his reception I found M. an emaciated, cachectic-looking man, with a dirty, yellow complexion. The integument was remarka-

bly dry, with numerous fine scales; the hair was scanty, dry; gait slow; respiration difficult. Examination of the organs of the chest showed tubercle at the apex of each lung (of old date ?), enlargement of the heart, with deviation to the right; the second respiratory sound strongly accented, no râles.

Liver and spleen considerably enlarged, on the right side dullness as far as the eighth rib, and some finger-breadths below the cartilages of the rib.

The liver dullness passed over uninterruptedly to the dullness of the spleen. The resistance of the liver considerably augmented, no knotty protuberances perceptible. The left hypochondrium considerably puffed up. A marked resistance was felt by the hand, from the crest of the ileum, as far as the nipple; the percussion from the fifth rib to the crest of the ileum showed complete dullness, which extended in the hypochondrium backwards to the spine, in front to the linea alba. On the gluteal region varices, scars on the prepuce and on the glans; the feet and legs edematous, on the tibiæ no nodes, but numerous highly-colored pigment spots on the skin of the lower extremities.

The urine contains much albumen, no casts, but pus cells and bladder epithelium. The blood was repeatedly examined by Prof. Stricker, and presented quite an extraordinary appearance. Upon microscopical examination the blood appeared pale-red, and resembled bloody matter rather than human blood.

The color was apparently caused by a multiplication of

the white corpuscles, which were easily recognizable by the microscope. Prof. Stricker writes to me, the number of colorless bodies I do not like to mention, it is not to the purpose. There are among them some so large that one of them might easily contain fifty or more red ones. I estimated, therefore, rather the bulk. It is certainly no exaggeration when I state that the bulk of the colorless surpasses that of the red corpuscles.

Even among the latter appeared some with nuclei, and some of these underwent at 38° to 41° Celsius, very great changes of form.

The colorless corpuscles did the same, of course, but the large ones were strikingly slower than the smaller ones.

The eyes appeared in a tolerable condition. There were on both sides small spots of pigment on the anterior part of the capsule, and on the left eye three filiform synechiæ. The appearance of the iris was pretty fair, both pupils reacted to light. The tension of the bulbs normal. The examination of vision, with moderate illumination, showed for both eyes E (Emmetropia) O. d. S = $\frac{20}{20}$; and O. s. S. = $\frac{20}{100}$. With the right eye J. No. 1 was read between 12″ and 5″; left, J. No. 5 uncertain, J. No. 6 clearly at 8″.

Ophthalmoscopic examination showed, on the right side, a condition quite similar to the above-described case of P. W.; the condition of the right eye is represented in Plate B. The color of fundus was pale orange-yellow. The yellow coloring did not disappear upon examination with daylight. The contour of the entrance of the optic nerve was, especially on its inner side, obscured, the veins

large, pale, rose-red, the closer to the pupil the more so; their contours were wanting in distinctness, the tissue of the iris, especially next to the veins, was obscured in many places, while in the other places even the small vessels and the translucent choroid could be clearly recognized. The arteries were thinner, pale-yellow, and showed in general a much sharper outline than the veins. But the most striking thing was a shining yellowish-white spot, situated almost exactly in the position of the macula lutea, about the size of $\frac{1}{4}$ D, surrounded by a dark-red margin, to which was joined towards its exterior quite a number of little roundish spots, also shining and similar in color. The figure upon Plate B represents this condition, with of course, not too great fidelity. At the examination with the upright image, and with the binocular ophthalmoscope, it could be seen with tolerable certainty that this yellow spot was prominent anteriorly, and more in the middle than at the sides.

This spot might, therefore, be considered as a small tumor. Its position could not be located to a certainty with the mirror alone. I shall prove further on that its position was rather behind than on the retina itself. It appeared clear at once that the present disturbance of vision, and the veil of which the patient complained, depended on this tumor. To arrive at a certainty, I ordered the patient to fix his eyes upon a small black cross on a dead white paper, at a distance of twelve inches. It was then seen that he had a little to the right and below the point of fixation, an obliquely oval, pretty well defined

scotoma, of the size of 2 D. In the vicinity of this scotoma all horizontal lines were so deflected, that the upper ones made a curve downwards, and the lower ones upwards. Vertical lines showed in the vicinity of the scotoma the same phenomena in a less degree, *i. e.*, those lying to the left were deflected to the right, and those on the right to the left, and between was one scarcely deflected at all.

From the position of the scotoma the conclusion might be drawn, that its cause, if in the retina at all, was situated a little above and to the outer side of the macula lutea. The position of the yellow tumor in the plate corresponds to this conclusion. However, there appeared to be a disproportion between the size of the tumor and the scotoma, to the extent of the size of a papilla. The size of the tumor was equal ¼ D, the size of the scotoma equaled 2 D. But this contradiction is explained if we consider that the effect of a small swelling crowded between the retina and the choroid, or lying in the choroid and pressing the retina forwards, must necessarily have exerted an influence upon the functions of the retina beyond the boundary of the swelling. This position of the swelling shows the character of the existing metamorphopsia.

Foerster (Ophthalmologische Beiträge, p. 27) explains, as we know, a metamorphopsia in which parallel lines are deflected from the centre of the disturbance of vision, as resulting from a process of contraction in the retina which occasions that the images of straight lines are represented upon portions of retina which in a normal retina lie at a greater distance from that central point. If it is

permitted to reverse this sentence, then must a process by which the tissue of the retina is expanded, produce an opposite result. In the normal state the retina is extended over the convex vitreous ; now if it is pressed from the side of the choroid anteriorly it will become flattened and of a less convexity. Then a condition occurs in which at a circumscribed spot the retinal elements must be on the same level. Lastly the retina will take a convex position anteriorly, and may in this way pass beyond the curvature of its normal condition, and in an opposite direction. It is obvious that when this occurs the retinal elements must be drawn asunder, while up to this moment in the change of position just described, the percipient elements must be closer together than in the normal condition. A metamorphopsia like that described by Foerster may also depend upon an exudation behind the retina pressing it forward, as long as by the anterior curvature, the outline of the retina does not surpass the normal curvature. From all this it follows that a metamorphopsia of an opposite kind, as in our case, may be explained, if we take for granted that the retina is pressed strongly forward at one circumscribed spot by a swelling lying behind it. The phenomena of micropsy and macropsy must be demonstrable according to the relations described. I am sorry that I neglected to make an examination in that respect at the proper time.

At the beginning I was more inclined to connect this peculiar state of the retina with the syphilis from which the patient had suffered than with the enlargement of the

spleen. The more so as I had not at that time examined the blood, and my attention had not been drawn to leucæmia.

The striped obscuration of the retina which accompanied many of the vessels corresponds to that which is considered by Liebreich as characteristic of retinitis syphilitica.

Only after leucæmia was diagnosticated, and the peculiar properties of the blood were recognized, I remembered the neglected observations of Liebreich on retinitis leucæmica. It seemed to me beyond doubt that I had the same condition before me which had occasioned Liebreich to describe this new form of disease. My case differed only from that of Liebreich in the size and the peculiar position of the light-yellow spot. The little tumor was therefore not to be considered as a gumma of the choroid or retina, but as a collection of white blood-globules, or, if one will, as a little lymph tumor.

I followed the course of this change of the retina with the more interest. Atropine was introduced, and iodide of iron administered internally to the patient. Not to weary the reader, I shall communicate the most important facts in the course of the general disease very briefly.

The patient remained some weeks at the eye clinic, and left it in pretty much the same condition. He was privately treated by Professor Stricker, who wished to have him at his command on account of the interesting condition of his blood. The strength of the patient slowly diminished more and more, besides he was troubled with attacks of dyspnœa and violent diarrhœa. A methodical application of cold water gave him some temporary relief. After he

had been under observation about eight months he withdrew, and probably left Vienna. Unfortunately we had no opportunity of making a post-mortem examination.

I now return to the eyes. The faculty of vision of the left eye improved rapidly. After a fortnight, vision=$\frac{20}{70}$. With a diaphragm and convex glass of $\frac{1}{15}$ he read, in spite of the atropine, J. No. 3, at 6″. Corresponding to this improvement the red halo in the periphery around the little yellow tumor disappeared, the tumor itself as well as the little surrounding round yellow spots lost their brightness and prominence, the scotoma turned pale, and the metamorphopsia was less definitely marked. By the 19th of December, vision $=\frac{20}{40}$ and J. No. 1 was read without a glass at a distance of 6–7″.

A dirty, yellow obscuration remained in the place of the little tumor, which was composed of separate little yellow spots. The red halo was entirely gone. The figure on Pl. C is an effort to represent the appearance of this spot. The scotoma was scarcely recognizable, distortion of objects not perceptible.

Central vision remained in this condition until April, 1867, when I, as far as I remember, examined the patient for the last time. Notwithstanding the great improvement of vision the patient said he saw worse with the left eye than formerly. As in the right eye normal acuteness of vision and accommodation had appeared as often as he had been examined, the assertion of the patient is entitled to full credit.

While I saw these changes in the region of the macula

lutea taking place under my own eyes, I observed accidentally at the end of January that similar little whitish yellow tumors had formed in or behind the retina, about three papilla diameters above and internal to the papilla, besides a larger vein branching out in the same situation.

They are represented on Pl. C, and relieve me from the necessity of any further description.

Quite a peculiar appearance presented itself in the neighboring vein. More obscure and less definite in outline than any other in the same eye, very tortuous and bordered on both sides by a yellow ribbon-like stripe, it appeared to me different from any thing I have ever seen except in the second case of retinitis leucæmica. (See above.)

It remains to be mentioned that the peculiar appearance commenced a short distance from the papilla. Unfortunately as accident would have it I was not able to follow up the formation of these changes. But they must have progressed very rapidly, as I examined the patient very frequently, and had not noticed any thing of them the last time I examined him. These spots commenced after a few days to disappear, and at the end of six weeks almost every trace of them had vanished. Of the histological and anatomical relations of these yellow spots we can only surmise, as anatomical examination was wanting.

However, as such examinations have been obtained from other sources, I will mention the conclusions that may be deduced from an unbiased consideration of such observations.

I shall not state any thing further with regard to the clini-

cal diagnosis of the general diseased condition of the patient. It is sufficient, if from the description of the case it is evident, that it is a case of well-marked leucæmia.

I will not decide whether it was caused by the preceding intermittent entirely, or partly also by syphilis, *i.e.*, whether syphilis had its share in producing the great enlargement of the spleen.

It is enough for me to state that the peculiar quality of the blood reminds one of the observations published by Friedreich (see Virch. Arch., vol. 41, p. 404). It is easy to conclude that in blood which is so much changed, not only the white, but also the red corpuscles which are mingled with them, have a tendency to exude more easily.

These white masses would be nothing else than agglomerations of lymphoid cells exuded from the vessels. As they retain in the tissue their mobility unimpaired, it is easy to understand that these masses may divide again after some time, as the cells pass on in different directions and become dispersed. It is not known to me whether similar collections of lymphoid cells appear in other organs in leucæmia, and it remains unexplained why the exuded cells collect in certain situations. The peculiar ribbon-like stripes beside the large vein upon Pl. C would find its explanation in this view. They are dependent upon the freshly-exuded white blood corpuscles collected along the sides of the vessel. The cloudiness already mentioned as appearing upon some of the vessels might be explained in a similar way. It is particularly difficult to decide whether these conglomerated exudations of white corpuscles which causes their accumu-

lation in larger masses takes place from the vessels of the retina or the choroid. The appearance of the retinal vessels, as likewise of the place of the second spot in the neighborhood of the larger vein, would indicate that it proceeded from them. But the position of the spot in the immediate neighborhood of the macula lutea, which is represented on Pl. B, hardly agrees with this supposition.

Again, it must appear surprising that many small lymphoid bodies have collected just at a spot where few or no vessels are found. It is also difficult to explain that if all these cells are situated in the tissue of the retina that it should not have lost its function. But we have seen above, that there is still vision at this spot, although the outlines of objects are distorted, and the acuteness of vision is considerably diminished in the immediate neighborhood, *i. e.*, at the macula lutea. For this reason it appears more probable to me that here the vessels of the choroid had furnished the mass of the cells. There needs no further explanation of the general and peculiar color of the fundus, which may be deduced from the peculiar color of the leucæmic blood circulating in the choroid, and the whole image which the fundus exhibits in leucæmia may be inferred in the same way from the altered quality of the leucæmic blood, as the color of the fundus is directly dependent on the changed color of the blood, and, further, the dim-yellow appearance of the arteries corresponds to the pus-color of the blood, while the rose-colored appearance of the veins depends upon the difference which likewise takes place in leucæmia between arterial and venous blood.

The size of the veins, their swollen indistinct appearance, the white stripes on their sides, and the partial cloudiness of the retina which accompanies them, all find their explanation, if we bear clearly in mind the process of a large exudation of white corpuscles by which the vessels themselves are plugged up, while others stick fast in the walls, and a greater or less number are exuded. Why the cells now and then collect in the tissue or between the retina and choroid in greater numbers, remains of course unexplained. It will be seen that I have endeavored to give the explanation of the ophthalmological appearances according to Cohnheim's view of the nature of inflammation. If this view is accepted as correct, and proven, there can be no hesitation in considering such appearances in the fundus of leucæmic persons as the consequence of an inflammatory process; and as in every case the retina suffers, as is proved by the appearance of its vessels and the cloudiness of its tissue, there can be no objection to the designation of retinitis leucæmia or retinitis from leucæmia. It remains, nevertheless, very surprising that, as I have stated from the beginning, the observations of Liebreich have been so seldom confirmed. When I conversed with Liebreich a year ago on this subject, we arrived at the conclusion that retinitis leucæmica has so far been so seldom observed because it has not been looked for. When I made a similar observation at the Ophthalmological Congress in Heidelberg, 1868, Knapp replied that he had looked for it but had not found it.

I too have since had the opportunity of examining a case of well-developed leucæmia at the clinic of Prof. Friedreich

without being able to discover the least alteration in the fundus of the eye. It remains therefore still undecided why in one case the change of color and the exudations are found, and not in another, although it is natural to attribute it to the difference of the disease which causes it, leucæmia itself, or differences in the quality of the leucæmic blood. This is the reason why I have communicated in the case related the history of the disease with such minuteness. From the same it may be seen that even in this case the retinitis leucæmica could have been overlooked if the local changes had not taken place exactly in the spot of direct vision. Only to this peculiar circumstance I am indebted for the opportunity of observing the case.

The object of the preceding article will be accomplished if pathologists and our special colleagues are led to examine all cases of leucæmia with the ophthalmoscope.

Numerous observations must at last lead to the knowledge of the special conditions under which leucæmia produces inflammation of the retina. Besides, it is not improbable that from ophthalmoscopic examinations valuable discoveries may be made in special cases of leucæmia.

Explanation of the Plates.

Plates B and C are drawn from the inverted image, and taken from the left eye. The representation on Pl. B was sketched in the beginning of December, 1866; that on Pl. C, about nine weeks later.

A CASE OF PYÆMIA FROM SUPPURATIVE INFLAMMATION OF THE CAVITY OF THE TYMPANUM, INDUCED BY THE USE OF WEBER'S NASAL DOUCHE.

BY D. B. ST. JOHN ROOSA, M. D.,

Clinical Professor of Diseases of the Eye and Ear in the University of New York.

On the 12th of December, 1868, I was consulted by a clergyman of forty-nine years of age, at the instance of his family physician, J. Foster Jenkins, of Yonkers, N. Y., in regard to a subacute catarrh of the cavity of the tympanum, affecting both sides of the head. The history of the patient was as follows: Some three years before he was attacked with what seemed to be hay fever, or a form of coryza attacking certain persons during the summer. This coryza was not relieved by any treatment, although a voyage to Europe was included among the means employed, but it became a chronic catarrhal inflammation of the naso-pharyngeal region, attended by the usual symptoms, viz., a sense of stuffiness of the nostrils, frequent expectoration, sneezing, &c. For the past two months the patient had been in the daily habit of using Weber's nasal douche for the purpose of cleansing the nostrils, and of introducing remedial agents into them. He had once before tried this means of treatment, but it had caused so much unpleasant feeling in the ears, that he was obliged to desist

from employing it. For about two weeks these unpleasant sensations on using the douche have been again experienced. The patient complains of being deaf, and of having a full sensation in both ears, almost amounting to pain. The membrana tympani of each side is found to be reddened. An ordinary ticking watch, heard by a person with normal hearing power about six feet, is only heard when placed in contact with the auricle of each side. A leech was applied to each ear, on the tragus, the Eustachian tubes were rendered pervious by means of the catheter and Politzer's method. In a few days the membrana tympani assumed a normal appearance, and the hearing was restored by means of this treatment.

The patient then desired that an attempt should be made to relieve the trouble in the naso-pharyngeal region. The uvula and tonsils were relaxed, the whole mucous membrane of the upper pharyngeal space secreted excessively, and the patient had contracted a habit of constantly endeavoring to clear his nostrils. Fluids passed through the left nostril, but none through the right. The Eustachian catheter, however, passed without difficulty. The nostrils were cleansed by means of a nebulizer, salt and water being used in it, after which the parts were swabbed out with a solution of *Arg. Nit.* gr. x, ad ℥i. The patient improved under this treatment until Jan. 28th, when he was for some time exposed to the air of a winter's day, with the head uncovered (at the consecration of a bishop), when the symptoms, which had been to a certain extent relieved, returned. Jan. 31st, a gelatinous mass was found plugging up the inferior meatus of the right nostril, seeming to be attached to the floor of the canal. Portions of this were removed by torsion, at intervals of about three days, until Saturday, Feb. 6th, when what seemed to be the remainder of this growth was removed. The patient left the office, saying that his nostril was much clearer, and went to Yonkers, a town about ten miles by rail from New York. He there again used the nasal douche, and again experienced a decidedly unpleasant

sensation in his ears, which, however, did not amount to pain. On Sunday morning and evening the patient performed his clerical duties, but with a great sense of languor and uneasiness. On Sunday night, February 7th, at about eleven o'clock, he was awakened by a severe pain in the mastoid region of the right ear, which kept him from sleep. I saw him Monday morning at about eight o'clock, and noted the following symptoms:—The countenance was anxious and flushed, skin hot, pulse about ninety-six, right mastoid region red and sensitive, right membrana tympani reddened, watch only heard when pressed upon the auricle. The patient was asked as to the condition of the left ear, but he said there was no trouble there. An examination of the tragus and mastoid process failed to exhibit any symptoms of inflammation in that ear. Two leeches were ordered to be applied to the mastoid process, and the patient was to take *aq. acetat. amm.* At 5 P. M. the pain in the ear had entirely ceased after the application of the leeches. The patient was breathing hurriedly, however, his pulse was weak and frequent, about ninety-six, and he complained of pain and tenderness in the abdominal region. Morph. Sulph. gr. $\frac{1}{8}$ was ordered to be taken *pro re nata*, and a poultice was applied over the abdomen.

Tuesday, Feb. 7.—The patient took two powders of morphine and passed quite a comfortable night. This morning he complains of pain in the forehead, but has none in any other part of the body. The surface of the body is dry and hot. Ordered *aq. acetat. amm.* and nutritious diet.

Feb. 8.—Last night the patient was attacked by a severe pain and swelling of the left foot, and at about 7½ A. M. he had a severe chill, lasting about fifteen minutes; not followed by sweating. At about this time a discharge appeared from the left ear. There has been no pain experienced in this part. He has not slept well, and his general appearance is bad. Countenance anxious. Breathing labored. Pulse about 96. The left ankle and dorsal region of foot

are red, greatly swollen, and tender. *Left* membrana tympani ulcerated and discharging freely.

Dr. Foster Swift, of this city, was called in consultation, and the following treatment agreed upon. The foot was wrapped in an alkaline lotion, Vichy water was given *ad libitum*, with beef-tea and wine, morphine *pro re nata*.

Feb. 9.—Patient does not seem so well. Respiration is hurried. The intellect is somewhat clouded. Pulse about the same. Face of a sallow hue. The stimulants are increased so that he now takes half an ounce of brandy in milk punch every four hours, day and night. Quin. sulph. gr. 2, every four hours. The left ear is syringed with lukewarm water, *Zinc. Sulph.* applied, and Politzer's method used to inflate the drums. The patient is so deaf, that he only hears when spoken to near the ear.

The patient was treated in this manner, until Feb. 22, the brandy punch being steadily increased until he was taking two ounces every four hours, with beef tea, eggs, &c. His pulse was never over one hundred, usually about 96, the skin had a saffron hue, and patient lay in a doze, except when the pain from his foot kept him awake nearly the whole time. *Dr. George A. Peters*, surgeon to the New York Hospital, was called in consultation, a few days ago, in addition to Dr. Swift and myself, and to-day two openings were made in the foot, one near the internal, and one near the external malleolus. Pus was evacuated. The dorsal region of the foot was very much swollen, but no fluctuation was detected. The patient's general condition is now better. His countenance less anxious, the respiration is not so hurried. The urine was several times carefully examined during the treatment. No abnormal condition was found, beyond an acid reaction early in the course of the disease.

Several openings were made in the foot from time to time, but the patient slowly improved from this time until March 16th, when he

was able to sit up. The membrana tympani healed, and the hearing distance became about one foot on the right side, and four to six inches on the left. Conversation is heard with ease, Politzer's method has been practised every two days. *Quinine* and *Iron* have been taken in addition to the stimulants. The foot is still swelled, but all the openings but two have healed.

April 4.—The patient has been going about the house for a week. Hearing power is still further improved. A little erysipelatous soreness of the foot occurred last night. The naso-pharyngeal catarrh is completely gone.

April 7.—Patient rode out to-day, and gets about the house, employing himself in intellectual labor. Tissues of the foot still swelled and rigid—motions of the ankle-joint unimpaired.

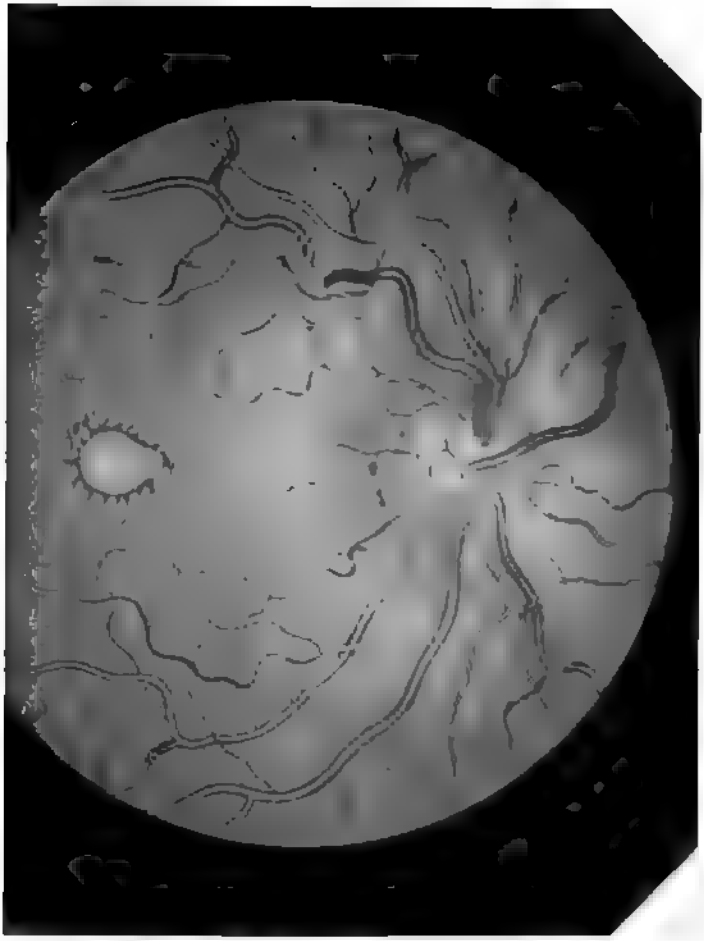
REMARKS.

The foregoing history seems to indicate that this was a case of metastatic abscess, arising from the suppurative inflammation of the left membrana tympani. The exciting cause of the aural inflammation was, I think, the use of the nasal douche. I am the more inclined to believe this from the fact, that on two previous occasions, I have seen the employment of the douche cause considerable trouble in the ear. In one instance the drum was ruptured by its use. I have seen few cases where the use of the douche could be tolerated for any length of time. Its daily employment is very often attended with great discomfort. Instead of the douche I use the posterior nares syringe, which is safe, and pleasanter to the patient than Weber's method. Judging from the sensations described by the patients who use the douche,

it is probable that fluid passes through the Eustachian tube into the cavity of the tympanum, and thus becomes a cause of inflammatory action.

Metastatic abscesses occurring from chronic otorrhœa, which has suddenly taken on an acute form, are not very rare; but I believe that few cases have been recorded where such a purulent infection took place during a primary affection, and certainly none have been published where the use of the nasal douche was considered the cause of the aural inflammation.

Tab. I



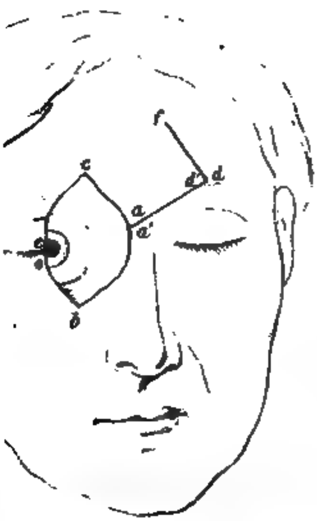
Retinitis leucaemica I

ad nat del

Carlsruhe, Chr Fr Müller'sche Lith Ar

Tab. I.

Fig. 1



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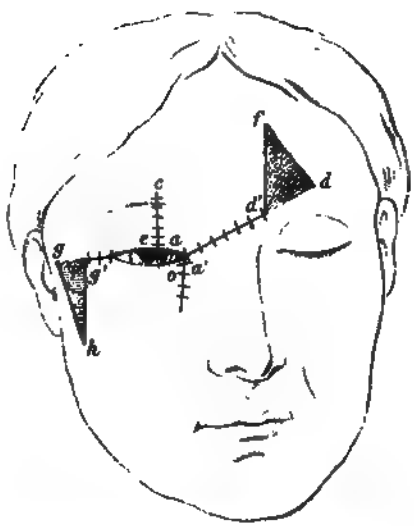
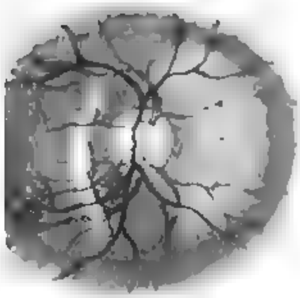


Fig 3



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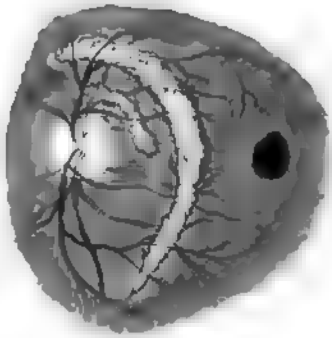
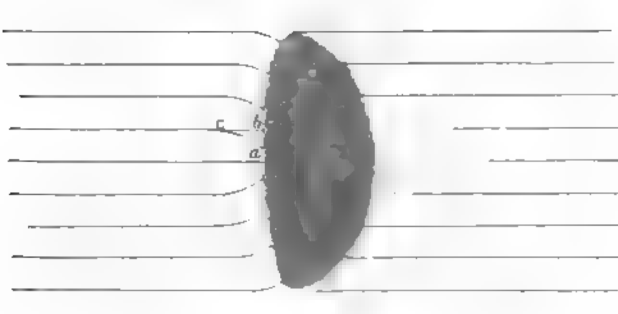


Fig 4. A



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Tab. II

Fig. 4. B

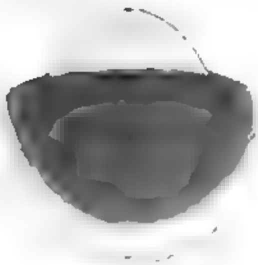


Fig. 5

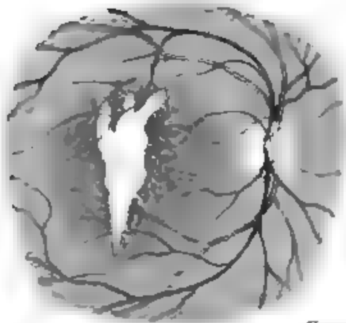


Fig. 6

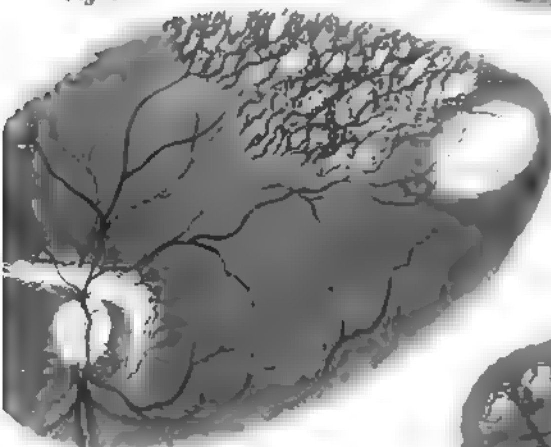


Fig. 4 C

Fig. 7

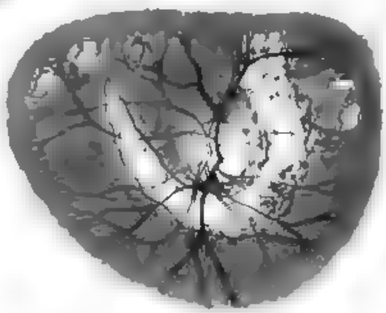


Fig. 9

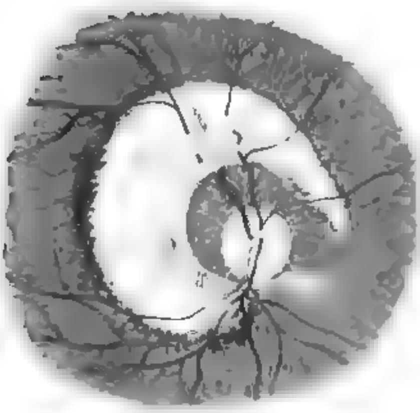
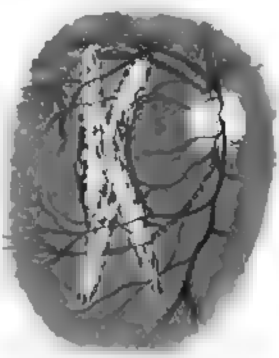


Fig. 8



pp. ad nat. del.

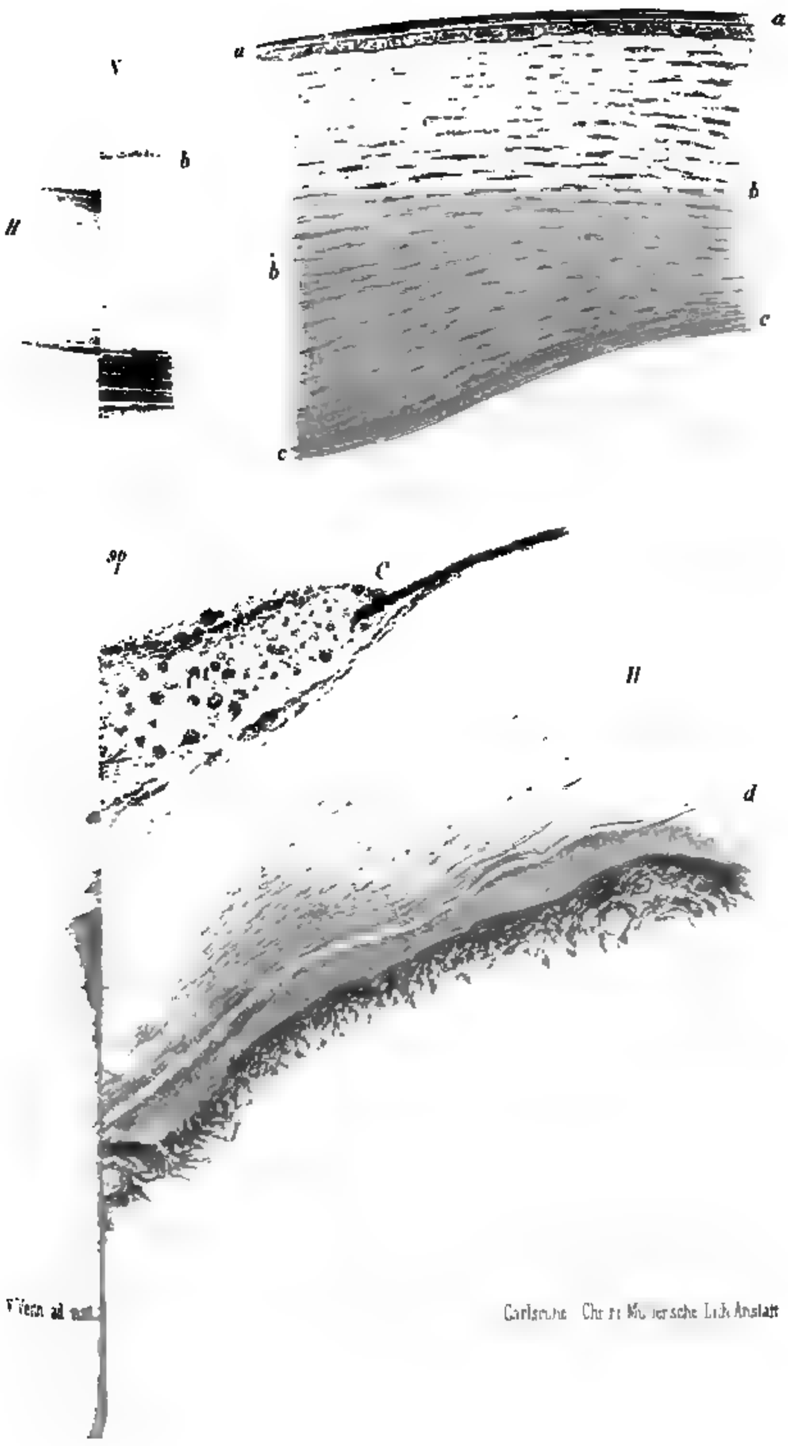
Carlsruhe Chr Fr Müller'sche Lith. Anstalt

Tab. III

Fig 2 $\frac{320}{1}$

Carlsruhe Chr. Fr. Müllersche Lith. Anstalt

Fig. 2 $\frac{320}{1}$



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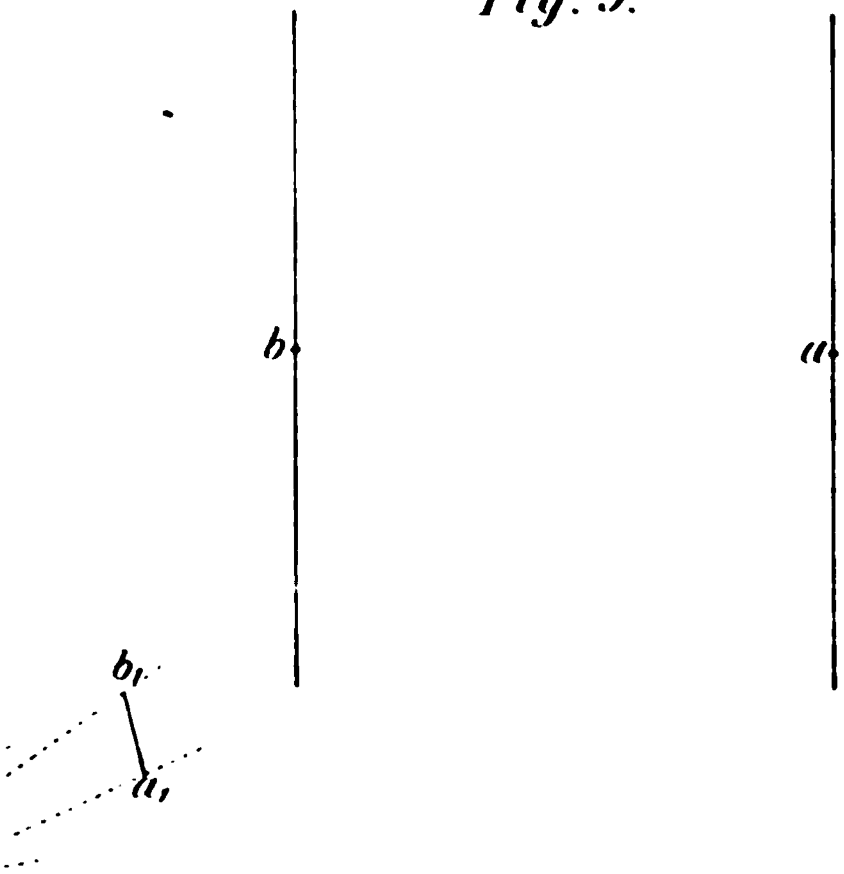
Carlsruhe Chr. Fr. Müller'sche Lith. Anstalt

Fig. 15.

Fig. 5.



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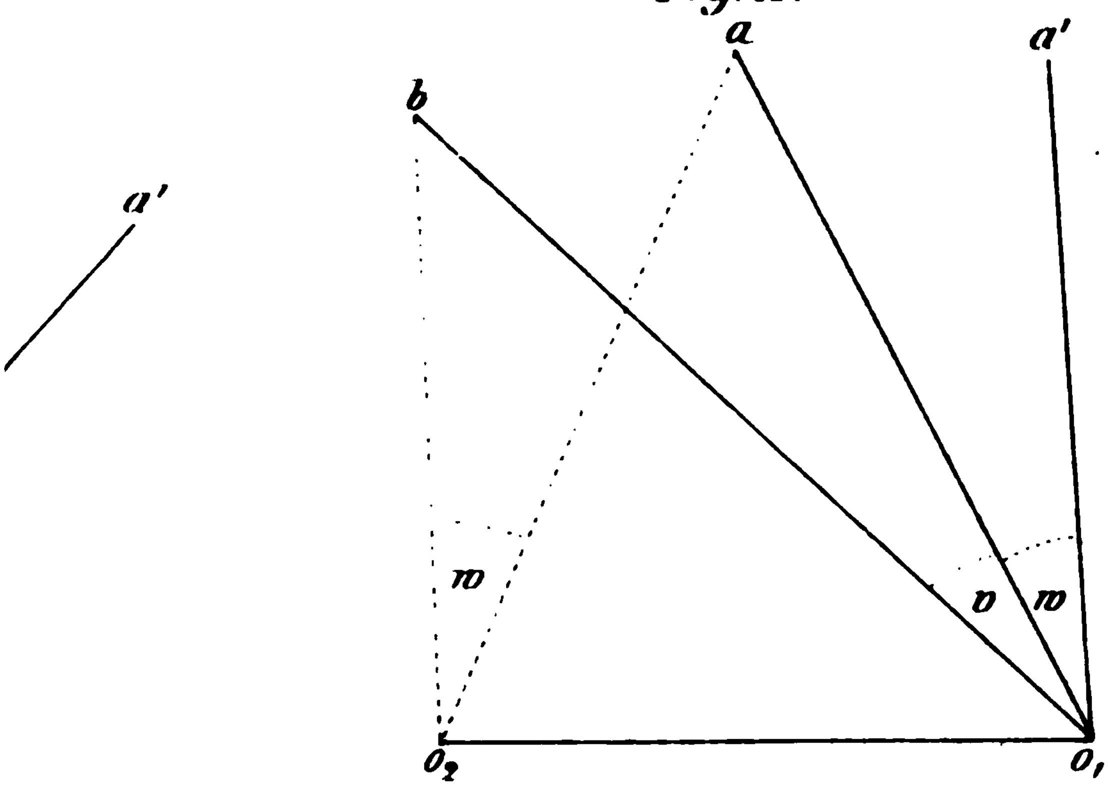

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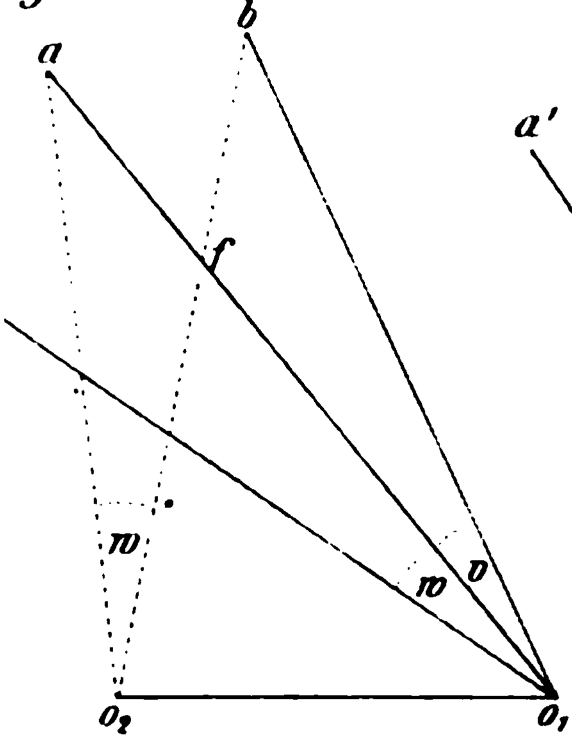

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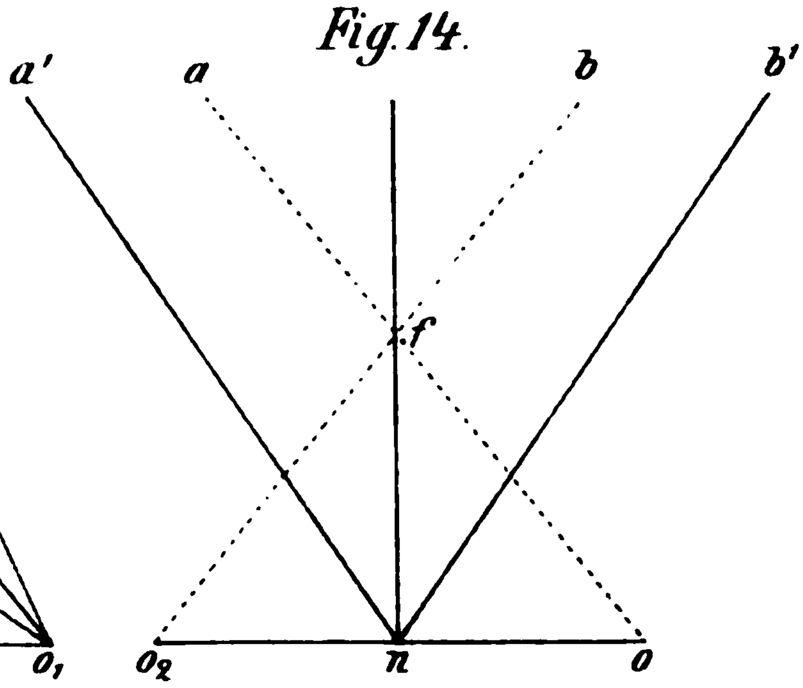
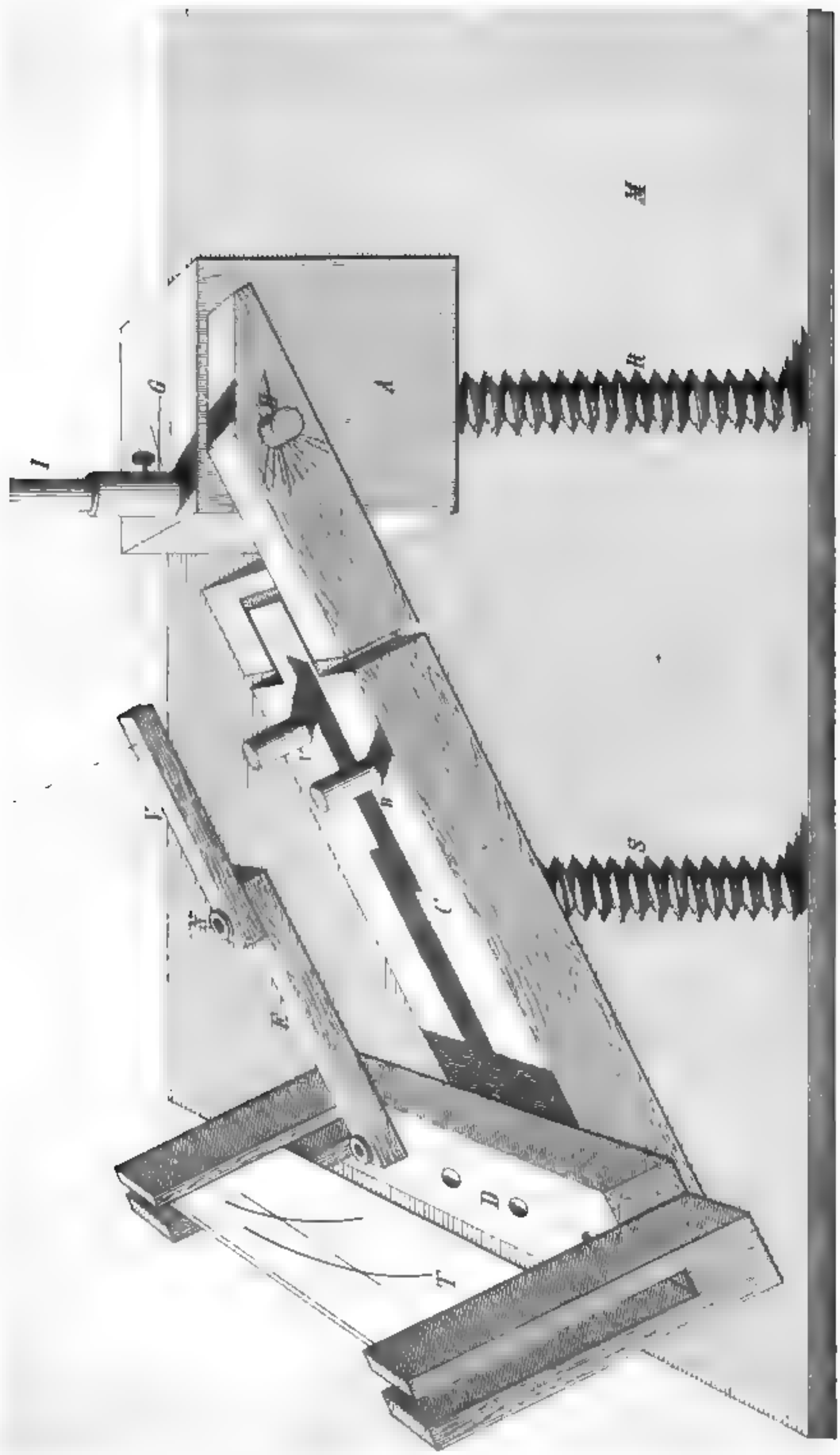
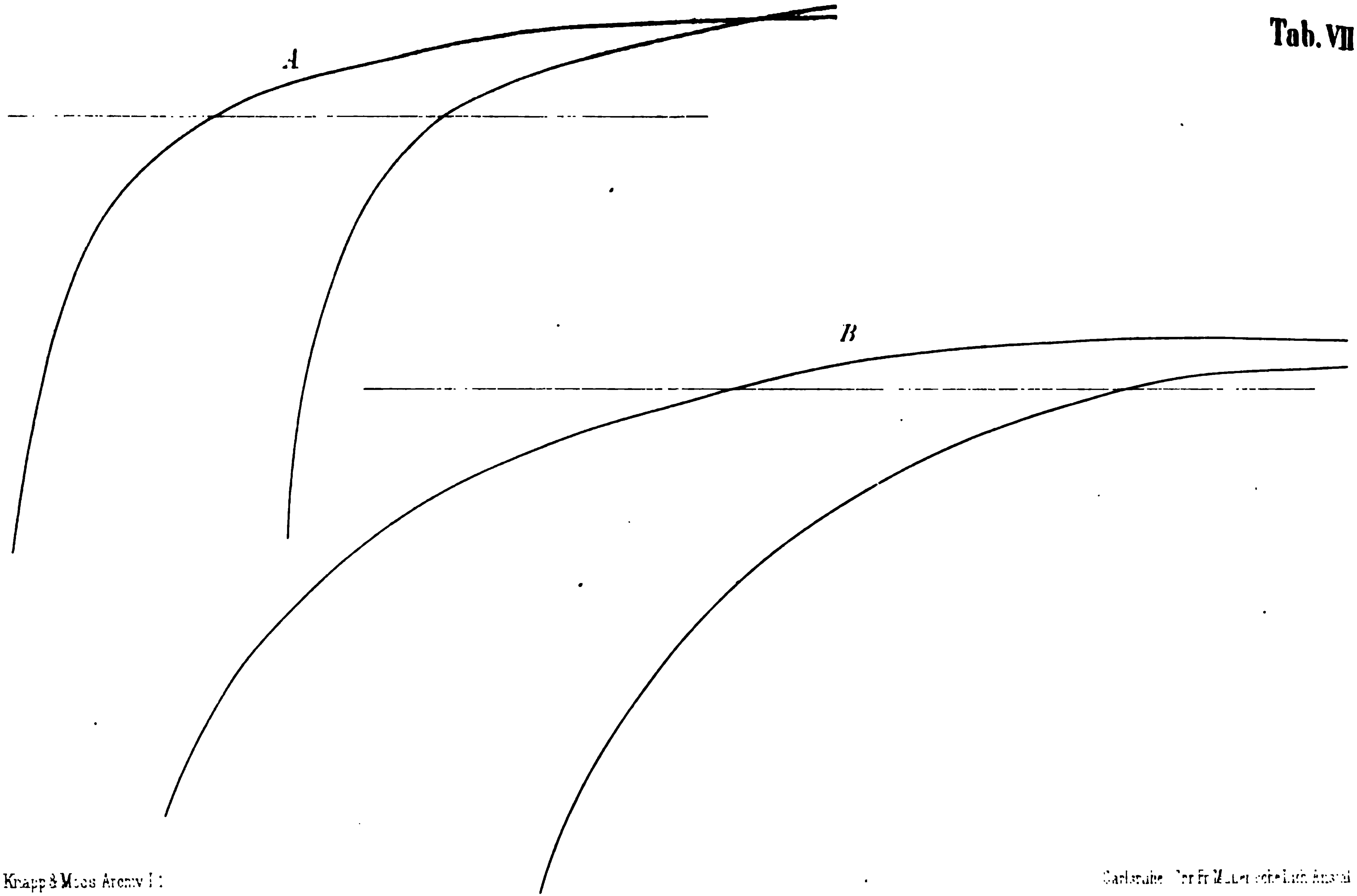


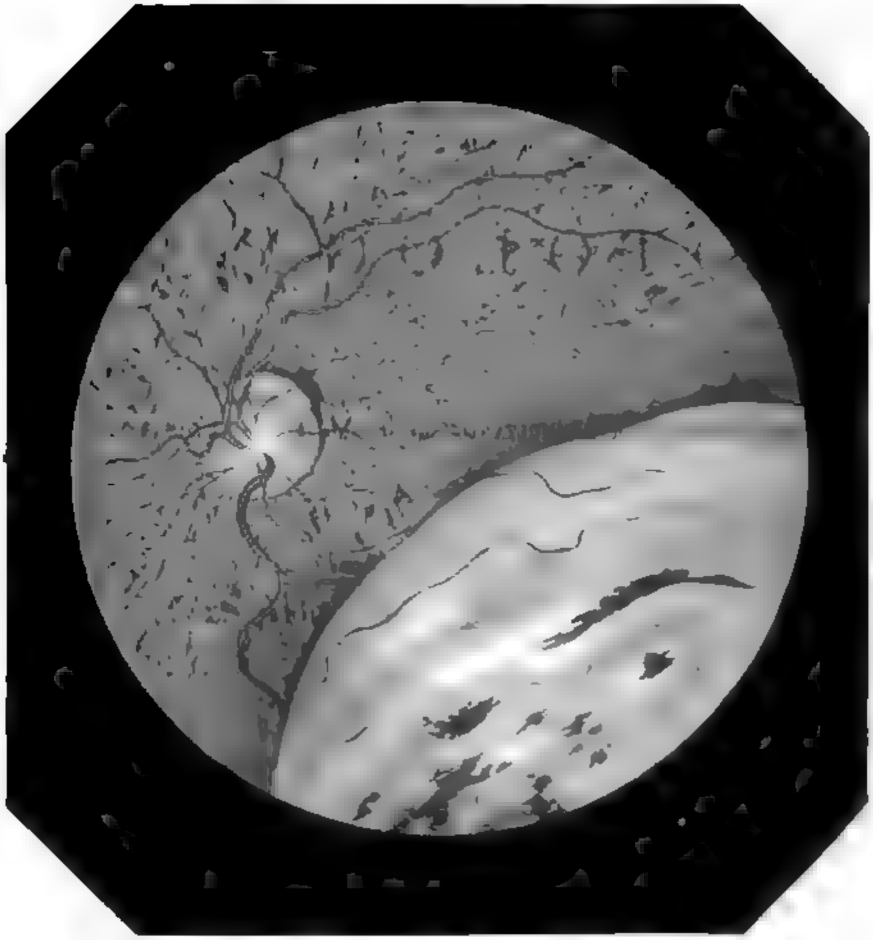
Carlsruhe. Chr. Fr. Müllersche Lith. Anstalt.



Tab. VII.



Tab. A.



Sarcoma chorioideae I

Dr. C. Heymann ad nat. del.

Carlsruhe, Chr. Fr. Müller'sche Lith. Anstalt

ARCHIVES

OF

OPHTHALMOLOGY

AND

OTOLOGY.

EDITED AND PUBLISHED SIMULTANEOUSLY IN ENGLISH AND GERMAN

BY

PROF. H. KNAPP, M.D., IN NEW YORK,

AND

PROF. S. MOOS, M.D., IN HEIDELBERG.

VOLUME I., NO. 2.

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CONTENTS OF NUMBER II.*

* In the table of contents for the first number, the title of a paper has been omitted, viz.:—

PURULENT OTITIS MEDIA, CAUSED BY THE NASAL DOUCHE, AND ACCOMPANIED BY DOUBLE HEARING.

By H. Knapp.

The use of *Weber's* nasal douche for diseases of the naso-pharyngeal region has of late become very extensive. Some recent publications, however, show that it is not without serious danger. Dr. *D. B. St. John Roosa* describes in the first number of these Archives (p. 259, etc.) a case in which the origin of a purulent inflammation of the middle ear, of the very severest kind, could be traced to the use of the nasal douche. He adds that he had observed other cases in which the nasal douche was followed by bad symptoms, and that it hardly ever could be tolerated for any length of time. *S. Moos*, in a note to the German translation of Roosa's communication, confirms these views by stating that he saw the fluid which had been injected into the nostril by Weber's douche, flow out of the ears in two cases of perforation of the drum-head. Although the application of the douche is not hurtful in such cases, they prove that

water thus introduced into the posterior nasal space may penetrate through the Eustachian tubes into the tympanic cavity. Moos, too, saw a case in which an acute aural catarrh was brought about by the nasal douche. The practical importance of these observations induces me to communicate a case of a similar kind :—

A merchant of New York, 32 years of age, was in the habit of injecting, by Weber's douche, warm water into his nose for chronic catarrh. He once took *cold water*, and felt, immediately after the injection, considerable pain in both ears, disappearing, however, very soon. Since that time he used warm water for six months without any unpleasant symptoms. Then he employed cold water once again, and experienced instantly in his left ear a severe pain, which soon abated, but nevertheless continued dull and annoying for a fortnight. Then suddenly it increased very much, was combined with headache, throbbing in the ear, loss of appetite, and deafness. Three days later an abundant purulent discharge from the left ear set in. He came to my office presenting all the symptoms of a very severe otitis media, with perforation of the membrana tympani. He remained under my treatment from March 6th to April 11th. Three weeks after his first call a great improvement had been obtained, the discharge was stopped, and the perforation in the drum-head closed for four days. Then an exacerbation and a new perforation occurred. The discharge kept flowing for a fortnight, when again an improvement was obtained, and the patient left New York to complete his recovery under the care of his father, a physician in the neighborhood of Philadelphia.

There is no doubt that the purulent inflammation of the middle ear was caused by the flowing of *cold* water into the tympanic cavity. Whether warm water sometimes or usually passed into the drum during the use of Weber's douche cannot be ascertained, since the patient

never felt it. I am satisfied that water can penetrate into the drum only when the patient accidentally swallows during the time the current is running over the orifices of the Eustachian tubes. It is easily explainable that cold water is more apt to provoke involuntary swallowing than warm. Moreover, the latter, when passing into the tympanum, would probably not cause much reaction or bad consequences. It therefore is certainly less objectionable than the use of cold water in cleansing the nasal and upper pharyngeal region. Since the observation above related, and the communications of *Roosa* and *Moos*, I have not recommended any more the use of the nasal douche, but applied injections of astringent remedies by the posterior nares syringe. They are disagreeable for a great many patients, producing very unpleasant fits of sneezing and coughing, but their action is efficient, and, as it seems, devoid of danger. If we inject only small quantities of fluid, which is mostly sufficient, there is commonly no unpleasant reaction.

Besides its origin, the above case was very remarkable for a symptom not much noticed yet, viz., *double hearing with both ears. Tröltsch* and *Politzer* mention its occurrence only with two lines; *Moos* records in his "Klinik der Ohrenkrankheiten," p. 319, etc., what is known on it. There are three incomplete observations in older literature, to which are added two of *Moos* himself, and one of *Von Wittich.* The first of Moos' patients, suffering from acute aural catarrh, heard simultaneously the third of each tone he was singing. The catarrh and double

hearing disappeared both together very soon. The second patient had impairment of hearing from chronic aural catarrh for ten years. One evening, to shorten a fit of his habitual asthma, he anæsthetized himself by chloroform. On awaking his deafness was very much worse, and he heard all the sounds of the upper three octaves of a piano double. During the course of some months his hearing power diminished still further, the double hearing continued for some time, and ultimately all musical sounds appeared to him so perverse that music in general, which he had been very fond of before, became a perfect horror to him. In none of these two cases mention is made which ear perceived rightly the natural tone, nor whether the pseudo-tone was higher or lower in pitch. The only well-analyzed case of the few cases of double hearing which are on record up to this day, is the observation made by Prof. *Von Wittich* on himself. The excellent physiologist of Koenigsberg noticed, four weeks after an acute purulent otitis media, that he heard *all the tones of the middle octave of a piano half a note higher* with the diseased ear than with the healthy one. His explanation is, that an exudation into the tympanic cavity, by altering the pressure of the fluid in the labyrinth, had changed the tuning of the terminal fibres of the auditory nerve.

When I examined the patient whose history I have sketched above, three days after the discharge had set in, I found in the diseased ear the hearing power for noises very much diminished (a watch of 6′ hearing

distance was heard from $\frac{1}{2}''$), whilst musical sounds were nearly as sharply perceived as in the normal state. A large tuning-fork, placed on the glabella, was *heard double, and in the affected ear more strongly and about two tones higher than in the sound ear.* On trial with a piano I found out that the same anomaly existed for the tones of the middle and next higher octaves, but not for the deeper ones. It was not distinctly marked at which note of the musical scale the double hearing began, nor where it terminated. This anomaly existed unchanged during the first week, as long as the perforation of the membrana tympani was large and the discharge abundant. Then the double sounds gradually came nearer to each other in pitch, until, at the end of three weeks, they hardly differed by half a tone, and sometimes were heard separately only by strained attention. After the relapse the double hearing was again a little better perceived, but the two tones never differed so much as in the beginning; moreover, their difference in pitch was changing from day to day. I have not heard of the patient since he left New York.

This observation has many features in common with that of *Von Wittich*, above all, the origin of the anomaly in an acute purulent otitis media. The principal differences of both cases are the following: 1st. The pseudo-tone (that of the diseased ear) was higher in Wittich's, lower in mine, than the right tone. 2d. The difference of pitch between real and pseudo-tone was greater in my case than in Wittich's. 3d. The differ-

ence of pitch between both tones was changing in my case, but constant in that of *Von Wittich.*

I shall try to account for these differences, together with giving an explanation of the whole anomaly. The latter is most appropriately termed *diplacusis binauricularis,* in analogy with a similar anomaly of the organ of sight, viz., diplopia binocularis. *Helmholtz's* theory is perfectly adapted to explain binauricular diplacusis. In conformity with this theory we may compare the cochlear portion of the inner ear with a stringed instrument. Corti's arcs or fibres—the strings—are so tuned as to yield all the sounds of the musical scale. Both cochleæ represent two instruments in perfect accord. If a sound is produced in the air, the vibrations of the latter will be transmitted through both membranæ tympani and the chain of the ossicles to those strings of Corti's organ which are tuned for this sound, and thus sympathetic vibrations are occasioned in Corti's fibres, and conveyed to the brain by the filaments of the auditory nerve connected with the vibrating fibres of Corti's organ. The same external sound will excite in either cochlea corresponding (identical) acoustic nerve fibres by producing sympathetic vibrations in corresponding (identical) arcs of Corti's organ. In analogy with similar conditions of both retinæ, *those fibres of both cochleæ may be called corresponding or identical, the simultaneous and equivalent excitement of which generates but* ONE *sensation of sound.* This constitutes the anatomical and physiological foundation of single hearing with both

ears, in a similar manner as we see single with both eyes.

Now, suppose the strings of one instrument (Corti's organ) are tighter drawn, then this instrument will be differently, that is, higher tuned, so that a string which formerly made f. i. 300 vibrations per second now makes 350 per second. Say 300 vibrations per second correspond to the tone *c*, 350 to the tone *e*. If, now, the latter tone, *e*, is sounded at any musical instrument, it will excite sympathetic movements in all strings so tuned as to perform 350 vibrations per second. (I may disregard entirely the harmonics.) In the healthy ear this will be Corti's fibre corresponding to the sound *e*, but in the diseased ear 350 vibrations are now performed by a fibre which formerly performed only 300 per second, and which, of course, is still connected with that auditory nerve-fibre which always committed the impression of 300 vibrations, that is, the tone *c*, to the brain. Therefore this ear will engender the perception of the lower sound *c*, whilst at the same time the other one will engender the perception of the higher sound *e*. Such were about the conditions in the case of double hearing observed by me.

The opposite state must have been present in *Von Wittich's* case. He heard with the diseased ear the tone higher than with the healthy one. Suppose he heard with the latter the sound *c* (300 vibrations per second), and with the diseased the sound *d* (say 325 vibrations per second), then Corti's fibre, tuned in the healthy state

to 325 vibrations, must have been so much relaxed that it now made only 300 per second. An external sound, *c*, of 300 vibrations per second, will induce sympathetic vibrations in that of Corti's arc of either ear which is tuned to 300 vibrations. In the healthy ear the right sound *c* is perceived, but in the diseased ear the relaxed arc will continue to excite the auditory fibre which always conducted the impression of 325 vibrations per second, that is, of the sound *d*, to the brain. *Von Wittich* made a very ingenious experiment to confirm this theory. If two tuning-forks, differing in pitch by half a tone, were so put before the ears that the lower one was before the diseased, the higher before the healthy ear, only one sound was perceived. The tuning-fork which yielded a lower sound produced sympathetic undulations in the relaxed Corti's arc which formerly was tuned half a tone higher, and now the nerve connected with it is excited with its corresponding nerve in the other cochlea.

Thus it is evident that diplacusis binauricularis may be of two kinds, by *false higher tuning*, *tightening*, and by *false lower tuning*, *relaxing*, *of Corti's organ. In the latter the pseudo-tone will be higher*, *in the former it will be lower*, *than the right tone.*

The greater the difference in pitch, the greater will be the degree of false tuning, either by increased tension or by relaxation of Corti's organ. This principle explains the second and third points of difference between my case and that of *Von Wittich.* There was, at the beginning of my observation, a morbid action on the cochlea

about four times as intense as in Von Wittich's case. This morbid action, however, was not constant during the course of my observation, but decreased in proportion with the decreasing intensity of the inflammation. It was scarcely yet perceptible when the discharge had stopped and the perforation of the drum-head was closed. In a case of Dr. *Gumpert* (see *Moos*, l. c., p. 319) the difference of pitch of both sounds varied between a third, fourth, and octave during one week, and then disappeared entirely.

Of what nature the changes are which produce false tuning of Corti's organ, I am not at all prepared to answer. *Von Wittich* assumes that exudation into the tympanic cavity changes the pressure of the fluid in the labyrinth. In his case the membrana tympani seems to have been entire at the time when diplacusis was noticed, for he adds that neither filling of the auditory canal with water, nor inflation of the tympanum with air, produced any alteration in the double hearing. In my case diplacusis of opposite kind existed, with perforation of the membrana tympani. Is the integrity of the membrana tympani essential in relaxing Corti's organ? Does its perforation produce tightening of it? I am unable to answer these questions. The first of *Moos*' cases, acute aural catarrh, seems to be analogous with Wittich's observation. "The patient heard simultaneously the third of every tone." If here, what is not stated, but seems to be understood, the third was the pseudo-tone, then there existed, like in Wittich's observation, dipla-

cusis by relaxation of Corti's organ. The drum-head was not ruptured.

The other observation of *Moos*, where diplacusis was occasioned by anæsthetizing with chloroform in a case of chronic aural catarrh, seems to be an example of idiopathic false tuning of Corti's organ, that is, not dependent on inflammatory changes in the middle ear. I think that, for the present, it is of greater importance to collect more facts relative to this anomaly than to seek for a theory.

The symptom of double hearing, when further studied, may be not only of physiological significance, but assume practical importance. It may guide our prognosis and treatment, by demonstrating that in the respective cases the labyrinth is either primarily affected or participates in some other disease. I suppose also that diplacusis binauricularis will be more frequently noticed than has been the case hitherto, if our attention be directed to it. With regard to future investigations, I propose that our inquiries should try to solve the following questions:—

1. How great is the *difference of pitch* between the two sounds?

2. Has the *pseudo-tone the same intensity and clang-tint* (timbre) as the right tone (that of the healthy ear)?

3. Are these *differences constant or varying* during the duration of the anomaly?

4. Is the *pseudo-tone higher or lower than the right tone* (diplacusis by relaxation or tension of Corti's fibres)?

5. Is it possible to *obtain single hearing* by producing tones of different pitch before either ear? The tuning-fork placed before the diseased ear ought to differ so much in pitch from the tuning-fork placed before the healthy ear as the pseudo-tone differs from the right tone, but the difference in pitch must be of opposite direction, f. i., if the pseudo-tone is half a tone higher than the right tone, then the tuning-fork placed before the diseased ear must be half a tone lower than that before the healthy ear. If the pseudo-tone is lower than the right tone, then the tuning-fork before the diseased ear must be so much lower.

6. At which heights of the musical scale does double hearing begin and terminate, that is, *how great is the range of double hearing?*

7. Are the *limits*, on the musical scale, *between single and double hearing distinct or fading away gradually?*

8. If the entire Corti's organ of one ear be differently tuned from that of the other ear, compound tones and pure chords must appear dissonant in binauricular, but consonant in monauricular hearing, also when in the latter case the healthy ear is excluded from the act of hearing. But if only a part of Corti's organ of one ear be differently tuned from the corresponding part of the other ear, all compound tones and the purest chords must appear dissonant in monauricular as well as in binauricular audition. All music must be a horrible dissonance, as in the one of *Moos'* cases. The examination has to determine of *what kind these dissonances in monauricular*

and binauricular audition are, which will be possible by analyzing the anomaly according to Helmholtz's theory.

9. What is the *cause of diplacusis?* Is the latter dependent on a primary lesion of the labyrinth, or consequent to morbid processes in the middle ear? In what state is the membrana tympani? Is there any change in intra-auricular pressure?

A complete investigation of this kind may, at first, be fraught with difficulties, and perhaps deemed resultless; but let me remind the reader that diplopia, not long ago, was an abstruse subject too, which has now become most valuable with regard to diagnosis, prognosis, and treatment of a large group of eye-diseases.

THE INFLUENCE OF SPECTACLES ON THE OPTICAL CONSTANTS AND VISUAL ACUTENESS OF THE EYF.

By H. KNAPP.

(A.) INFLUENCE OF SPECTACLES ON THE ORDINARY EYE.

EVERY oculist at the present day is fully convinced that an accurate determination of the acuteness of vision (S) is of the greatest importance in the practice of ophthalmology. The older methods are now all given up in favor of ascertaining S by a rational system of test-types. In cases of anomalous refraction, S is found out by means of convex or concave glasses neutralizing the anomaly of refraction. That, in doing so, a certain degree of inaccuracy is introduced by disregarding the magnifying and diminishing influence of these glasses is evident, but the amount of this inaccuracy has not yet been calculated. Even *Donders*, in his very exhaustive treatise on the Anomalies of Accommodation and Refraction, does not touch this question. He says (p. 152) that, without further determination, a comparison of THE VISUAL ANGLES can only be made if the

visual object can be accurately seen *with or without auxiliary glasses.*

I purpose now to examine what influence on the visual acuteness these auxiliary glasses exert in ametropic eyes.

It is known that ametropia is caused not by any notable changes in the refracting media and their surfaces of separation, but by changes of position of the retina. Therefore we may assume that the optical constants of ametropic eyes are equal to those of emmetropic ones. I shall take as a basis for the calculation the values of *Listing's diagrammatic eye* given in most text-books, for instance, *Helmholtz's* Physiological Optics, p. 111, and *Donders'* Accom. and Refraction, p. 67. (In the latter there is a misprint: line 7 from the bottom of the page, anterior focal distance of the eye ought to be 14,858 instead of 19,875.)

To solve the problem in a general way, I shall calculate the optical constants of a compound dioptrical system, consisting of the normal (or diagrammatical) eye combined with the series of our common spectacle-glasses. This work has not yet been done, and may also prove useful in solving other questions relating to vision through lenses.

In the calculations I shall avail myself of the convenient formulas given in *Helmholtz's "Physiologische Optik."*

The usual distance at which spectacles are worn before the eye is about half a Paris inch. We may, therefore, place the auxiliary lens 14,858 mm. in front of the first principal plane of the eye. It is sufficiently accurate for

our present purpose to disregard the thickness of the glass lens, its two principal and focal points falling together and coinciding with the so-called optical centre. By placing the glass 14,858 mm. before the first principal plane of the eye, the optical centre of the first system coincides with the first focal point of the second system, the anterior focal length of the latter being 14,858 mm.

These suppositions made, we can proceed to *determine the position of the cardinal points of the compound system.*

f_1 and f_2 denote the first and second focal lengths* of the first system, which, being equal, may indiscriminately be represented by f.

ϕ_1 and ϕ_2 denote the first and second focal lengths of the second system, the eye;

And d the distance between the optical centre of the glass lens and the first principal plane of the eye.

$$d = 14{,}858 = \phi_1.$$

We find $a_1\,t_1$, viz., the distance of the first focal point of the compound system *in front* of the optical centre of the auxiliary lens by Helmholtz's formula 11*a* (l. c., p. 56).

$$a_1\,t_1 = \frac{(d - \phi_1)\,f_1}{d - \phi_1 - f_2}$$

d being equal to ϕ_1 and $d - \phi_1 = o$, we therefore obtain $a_1\,t_1 = o$,

* For the sake of simplicity of expression, I mean, in conformity with modern German opticians, by *focal length* always *principal focal length*, thus distinguishing it sufficiently from conjugate focal length or distance.

which signifies *that the anterior focal point of the compound system coincides with the anterior focal point of the eye.* This result is valid both for positive and negative glasses.

Formula 11*b*,

$$\alpha_2 \tau_2 = \frac{(d - f_2)\, \phi_2}{d - \phi_1 - f_2}$$

determines the position of the *second focal point of the compound system behind the second principal point of the eye.*

Let us illustrate the calculation by an example, say lenses No. 10, convex and concave, viz.: lenses with 270,6995 mm. of positive and negative focal lengths. By substituting the proper values, the preceding formula results in

$$\alpha_2 \tau_2 = \frac{(14{,}858 - 270{,}6995)\ 19{,}875}{-\ 270{,}6995} = 18{,}784 \text{ mm. for}$$

$+\ 10''$,

and

$$\alpha_2 \tau_2 = \frac{(14{,}858 + 270{,}6995)\ 19{,}875}{270{,}6995} = 20{,}966 \text{ mm. for}$$

$-\ 10''$.

Both these values, being positive, indicate the situation of the posterior focal point of the compound system *behind* the posterior principal point of the eye.

I shall now proceed to determine the *principal points of the compound system.*

Formula 11*d* (Helmholtz, l. c., p. 57)

$$h_1 = \frac{d\,f_1}{d - \phi_1 - f_2}$$

determines the *position of the first principal point of the compound system in front of the first principal point of the first system.*

As $d - \phi_1 = o$, and $f_1 = f_2$, we obtain

$h_1 = - d.$

The same result is arrived at whether the auxiliary lens be positive or negative, since f_1 and f_2 will in either case have inverse signs, thus rendering the value of h_1 negative in both instances.

The negative sign before d means that the first principal point of the compound system does not lie *in front* of, but *behind* the first principal point of the glass lens. As we made $d = \phi_1$, it follows that *the first principal point of the compound system coincides with the first principal point of the eye.*

Formula 11*e* (ibidem, l. c.),

$$h_2 = \frac{d\,\phi_2}{d - \phi_1 - f_2},$$

determines the position of *the second principal point of the compound system behind the second principal point of the second system*; f_2 being assumed positive, that is a convex lens (+10) placed before the eye.

As $d - \phi_1 = o$, we obtain

$$h_2 = \frac{d\,\phi_2}{-\,f_2} = \frac{14{,}858 \times 19{,}875}{-\,270{,}700}$$

$$h_2 = -\,1{,}0909 \text{ mm.}$$

This result shows *that by placing a convex lens No.* 10

before the eye, the second principal point of the compound system falls 1,0909 *mm. in front of the second principal point of the eye.*—The distance between the two principal points of the eye being 0,4160 mm., this quantity subtracted from 1,0909 shows *the position of the second principal point of the compound system* 0,6749 *mm.* IN FRONT *of the first principal point of the compound system.*

We have determined above the position of the second focal point of the compound system to be 18,784 mm. behind the second principal point of the eye. To find the *second focal length*, which is the distance between the second principal point and the second focal point of the compound system, we must add 1,0909 mm. to 18,784 mm. Thus we obtain the second focal length of the compound system

F_2 = 19,875 mm., which is = ϕ_2, the second focal length of the eye.

If we place a *negative lens* ($-10''$) before the eye, the second principal point is likewise obtained by formula 11*e*, with the difference only that f_2 being negative in this case, renders the value of h_2 positive, namely—

$$h_2 = \frac{d\,\phi_2}{d - \phi_1 + f_2} = 1{,}0909 \text{ mm.}$$

This shows that with negative glasses of the same focal length the second principal point recedes by the same quantity as it advances with positive glasses.

The second focal length of the compound system is,

therefore, obtained for concave glasses by subtracting this quantity from the value above found for $\alpha_2 \tau_2$, which expresses the distance between the second focal point of the compound system from the second principal point of the eye. Therefore,

$F_2 = 20{,}966 - 1{,}0909.$

$F_2 = 19{,}875$ mm. $= \varphi_2$.

Thus we have found *that the second focal length, F_2, of the compound system proves equal to the second focal length of the naked eye, whether for convex or for concave glasses.*

The position of the *nodal points* is now easily ascertained, as, in every system, the distance of the first nodal from the first focal point is equal to the second focal length. All these quantities of the compound system having been found identical with the corresponding quantities of the naked eye, the first *nodal point of the compound system must also coincide with the first nodal point of the eye.*

The equality of the posterior focal length of the compound system with that of the eye, has been obtained only by numerical calculation of one example, and from it the position of the first nodal point has been deduced. As this may not be considered sufficient evidence, I shall demonstrate it in a general way.

Formula 11*d*,

$$h_1 = \frac{d\ f_1}{d - \varphi_1 - f_2},$$

determines the position of the first principal point by the

distance (d) of the glass lens from the anterior principal point, moreover by the anterior focal length (ϕ_1) of the eye, and the focal length of the glass ($f_1 = f_2$). The position of the focal points of a compound dioptrical system may be determined independently from the principal points, by proceeding from the nodal points of the single systems in a similar way as by making use of the principal points. If d' signifies the distance between the second nodal point of the first system and the first nodal point of the second system, ϕ_2 the second focal length of the second system, and f_1 and f_2 the anterior and posterior focal lengths of the first system, the formula 11*d* is transformed into the following:

$$K_1 = \frac{d' f_1}{d' - \phi_2 - f_2}.$$

in which K_1 represents the situation of the anterior nodal point of the compound system *in front* of the anterior nodal point of the first system.

$d' = \phi_2$ and $f_1 = f_2$, we obtain

$K_1 = - d' = \phi_2$, that is, the anterior nodal point of the compound system lies *behind* the optical centre of the glass lens by a quantity equal to the posterior focal length of the eye, and, therefore, coincides with the first nodal point of the eye. Since the anterior focal point of the compound system likewise coincides with the anterior focal point of the eye, it follows that the posterior focal length of the compound system equals the posterior focal length of the eye.

If, instead of a convex lens, we place a concave one before the eye, these results remain the same, for f_1 and f_2, which now are negative, enter into the above formula with inverse signs, consequently the value and situation of K_1 will not be influenced.

The distance between the two nodal points being always, in every simple or compound system whatsoever, equal to the distance of the two principal points, *the second nodal point of our compound system must assume the same position relative to the first nodal point, as the second principal point to the first principal point of the compound system.*

Since, lastly, the second focal length of the compound system is the distance between its second principal and second focal points, and is equal to the second focal length of the eye, it is evident that *the second focal point of the compound system takes the same relative position to the second focal point of the eye, as the second principal and nodal points of the compound system to the second principal and nodal points of the eye.*

If we recapitulate the foregoing investigations, we notice the following remarkable result:—

Spectacle-glasses, held half an inch before the eye, do not change the situation of its anterior cardinal points, nor its anterior and posterior focal lengths, but the situation of each of the posterior cardinal points is altered in such a manner that convex lenses make them advance, and concave glasses recede by the same quantity.

Having arrived at this conclusion, our practical calcu-

lations are very much simplified, and, indeed, reduced to the evaluation of the position of either the second principal or second nodal point. This indicates at the same time what change has taken place in the position of the posterior focal plane, that is, the retina, and, consequently, in *the length of the ocular axis.*

After having, in this way, determined the *optical constants* of a compound dioptrical system, consisting of *the human eye and spectacle-glasses*, we may now proceed to investigate *what influence the latter have on visual acuteness.*

The *sharpness of vision in the normal eye is dependent on the density of the percipient retinal elements.* We may fairly assume that the number of these percipient retinal elements, and of the optic-nerve fibres connected with them, is the same in all normal eyes. If, nevertheless, we find variations of S in different eyes which we must consider as normal, these variations result certainly more from deficiencies in the optical part of the eye than from varying numbers of percipient elements and optic nerve-fibres. In diseased eyes, where the optic nerve, retina, and choroid have suffered, the sharpness of vision sinks in proportion to the destruction of percipient elements. *According to general acceptance, S is measured by the smallest visual angle, that is, the deviation of two lines which connect the second nodal point of the eye with two adjoining percipient retinal elements.* Hence it follows that the visual angle, and with it S, will change whenever the distance between the second nodal point and the retina changes,

the latter itself undergoing no alteration of structure. Spectacles move, as we have seen, the second nodal point, and therefore change the visual angle; but only in a few instances, viz., in presbyopia, and if the effect of weak glasses is counterbalanced by accommodation, we have to deal with normal eyes. The eyes which require spectacles in order to see at distance clearly and with ease, that is, without any accommodative effort, are not normal, but either too long (myopia), or too short (hyperopia). Since, however, as we have said at the beginning, the refractive parts of these eyes are normal, the shortening or elongation of the ocular axis can only result from advancement or retrocession of the posterior portion of the ocular membranes. The retina of such eyes may be, and mostly is, as normal as in the emmetropic eye, and therefore must contain the same number of percipient

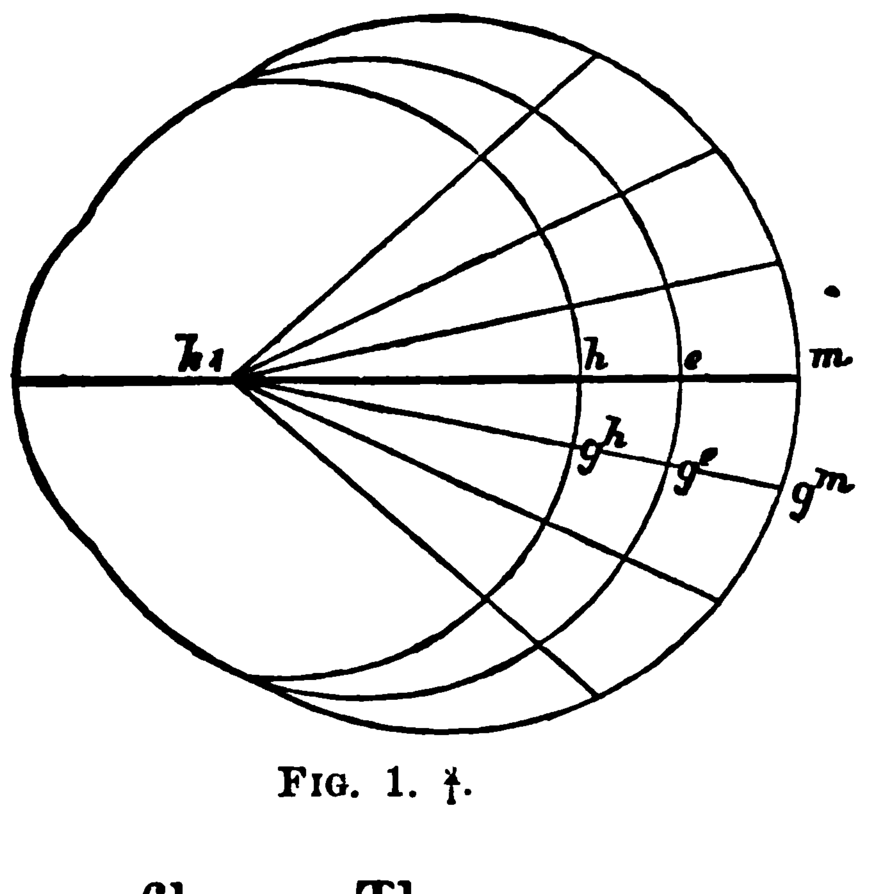


FIG. 1. ½.

elements and nerve-fibres. The necessary consequence of this fact evidently is, that the absolute density of the

retinal elements is greater in short (hyperopic), and less in long (myopic), than in emmetropic eyes. In hyperopic eyes, the retinal surface, with all its elementary parts, may be considered as contracted, in myopic eyes, as expanded. If, in Fig. 1, the three curved lines represent a hyperopic, emmetropic, and myopic eye, the radii drawn from the anterior nodal point (k_1), will embrace between them corresponding portions of the retina, with equal numbers of percipient elements. The same number of the latter which exists in the normal eye must be distributed over a smaller surface in the hyperopic eye, and over a larger surface in the myopic eye.

Let us now see *what influence spectacles exert on visual acuity.* Fig. 2 will illustrate this very plainly. *A B*

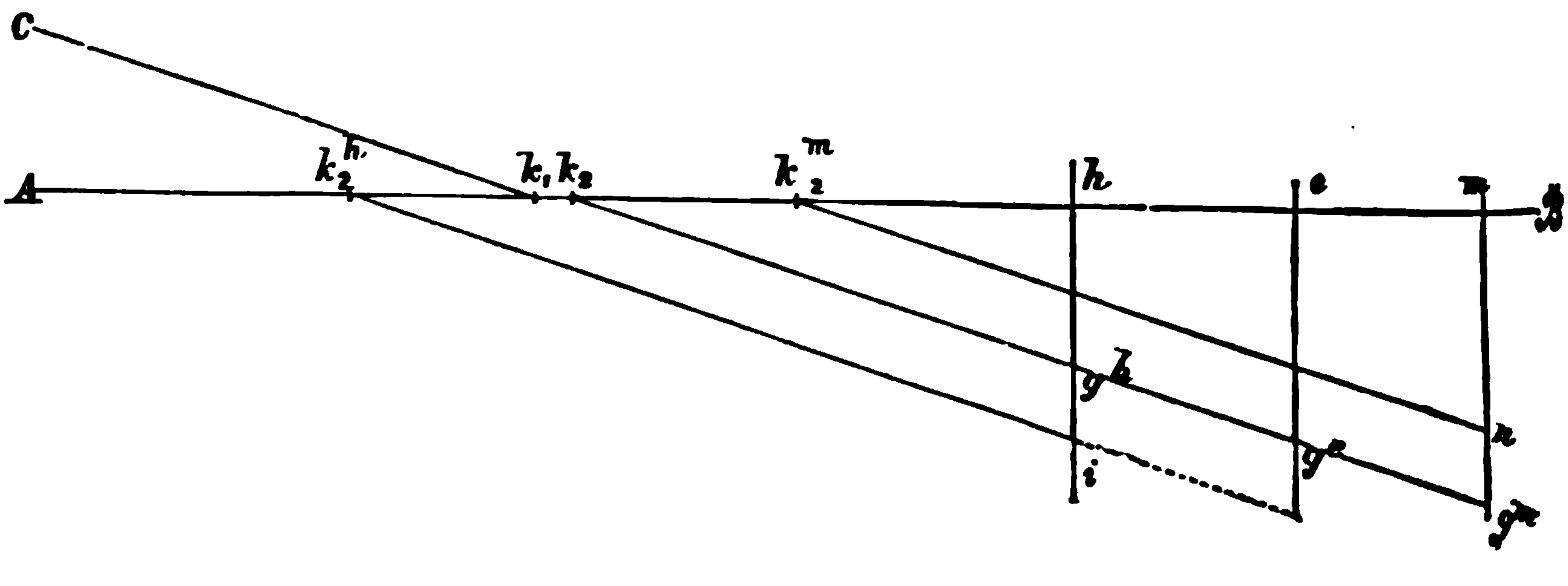


Fig. 2.

is to represent the visual line, k_1 and k_2^e the anterior and posterior nodal points, and *e* the intersection of the retina and the visual axis in the emmetropic eye. *h* and *m* are the points of intersection of the visual line and

retina, k_2^h and k_2^m the posterior nodal points in the hyperopic and myopic eyes, thus displaced by spectacles neutralizing the errors of refraction.

If the same object be looked at by each of the three eyes, it will appear under the same visual angle. This statement is at variance with the current opinion, that convex glasses, by advancing the nodal point, render the visual angle larger, and concave glasses render it smaller by making the nodal point recede. This would be true if both nodal points coincided, or were displaced, by spectacles in the same direction. In the naked eye they lie indeed close together, and during accommodative efforts their movements are homonymous, so that they may, for ordinary purposes, be regarded as coinciding. But for eyes armed with spectacles we are no longer allowed to make this concession, as I have shown above. Let, in Fig. 2, $A\,k_1$ represent the principal line of direction (principal axial ray of authors) of an object, Ck_1 a secondary line of direction (secondary axial ray), then the former will continue its course undeviated, while the latter will pass through the vitreous body parallel to its anterior portion (going through the air), but be displaced in such a way that the second nodal point (k_2^e) lies in the naked eye very little behind the first (k_1), further behind (k_2^m) in an eye armed with concave glasses, and in front of the second nodal point of the unarmed eye in eyes wearing convex glasses (k_2^h). If we consider (in Fig. 2) the different triangles which are formed by the primary and secondary lines of direction,

and the connecting lines of their crossing points in the retina, we see that all these triangles are similar to one another, and especially *the angles at k_2, the visual angles, are equal.*

When the *hyperopic eye* is not armed with spectacles, its retina, hi, is situate in front of its posterior focal plane, eg^e, but its posterior nodal point, k_2^e, lies in the normal place. The secondary visual line cuts off the portion hg^h of the retina. But when the hyperopic eye is armed with convex spectacles, the secondary nodal point advances (k_2^h), and the secondary axis cuts off, on the retina, a larger portion, hi, than it did before spectacles were added to the eye. The larger portion of retina must, of course, comprise a greater number of percipient elements. If we now admit that in Figs. 1 and 2 eg^e are two adjoining percipient elements of the retina, being approximated to each other, in the hyperopic eye, to the position hg^h, then we see that the addition of a convex glass causes, of the same object, a larger retinal image than the naked eye. If hg^h represents the extent of the smallest perceptible retinal image, say f. i. of No. xx. Snellen, seen at 20′ distance, the addition of a convex glass, increasing the retinal image of the same object to the extent of hi, would enable the same eye to distinguish at 20′ distance smaller type than No. xx. Sn. Thus we find its visual acuteness greater than $\frac{20}{xx}$, or $S > 1$. It is, therefore, evident that by wearing convex glasses the optical power of the eye increases, even if we leave out

of consideration the correction of the impurity of the retinal images.

Suppose somebody is able *to see at distance distinctly without and with convex glasses* (facultative hyperopia, *Donders*), then his eye, when unaided, would form the perfectly pure image hg^{λ}, and, when armed with a convex glass, the image *hi* quite as distinctly, but larger, of the same object. Therefore the eye, when armed with convex glasses, would be able to read smaller type than Sn. xx. at 20′ distance, that is, his visual acuteness would be greater than normal, according to our usual method of testing.

Both nodal points advance in every eye by accommodation. By A = $\frac{1}{4}$ this advancement amounts to 0,4 to 0,5 mm., causing an adequate aggrandizement of the retinal images equivalent to that produced by convex spectacles No. 24, as the table further below demonstrates. In this way we are able to compare the aggrandizement of the image caused by accommodation in the unarmed hyperopic eye, with the aggrandizement of the image caused by convex glasses in the hyperopic eye. To determine how much the magnifying effect of convex glasses exceeds that produced by accommodation, we take the former in the table further below, and deduct from it the aggrandizement produced by accommodation. If, f. i., a patient with hyperopia = $\frac{1}{12}$ wishes to see clearly at distance without glasses, he must make an accommodative effort of $\frac{1}{12}$. But this is only the third part of A = $\frac{1}{4}$; the aggrandizement by accommodation, therefore,

is only one-third of that produced by a convex glass No. 24, or equivalent to that of + 72. We shall, hereafter, see that the magnifying effect of glasses weaker than No. 10 may fairly be neglected for practical purposes; so much the more may we disregard the influence of accommodation on the size of the retinal images. Apart from that, it is the object of the present investigation to evaluate the changes of size brought about by spectacles in the retinal images, making abstraction of the optical purity of the latter. In that way only we obtain a correct measure to compare the visual acuteness of armed ametropic eyes with that of the unarmed emmetropic eye; for spectacles re-establish the purity of the retinal images, and render accommodation equal to that of the emmetropic eye; but in doing so they moreover exert some influence on the size of the retinal image, and it is the amount and consequences of this accessory factor we are endeavoring here to ascertain. The foregoing lines, however, solve the problem raised by *Donders*, and quoted at the beginning of this paper, that a comparison of the visual angles can only be made, if the visual object can be accurately seen with or without auxiliary glasses. Instead of visual angles we would now say the size of the retinal images.

The conditions of *myopic eyes* are easier to analyze. The retina, mg^m, Figs. 1 and 2, being distended, displays a less density of its percipient elements. The line mg^m may be supposed, as I have shown, to contain no more percipient elements than eg^e or hg^h in the emmetropic

and hyperopic eyes. If, now, mg^m (Fig. 2) is the smallest perceptible retinal image of an unaided myopic eye, the addition of a concave glass would reduce this image of the same object to the size of *mn*, by shifting the second nodal point from k_2^e backward to k_2^m. The dimension *mn* being less than the distance of two adjoining percipient elements, or less than the smallest perceptible retinal image, the addition of a concave glass has rendered visual acuteness less than normal.

The amount of increase or diminution of visual acuteness brought about by spectacles is proportionate to the increase or diminution they produce in the retinal images. This amount may be estimated as follows:

(*A.*) *Calculation of the amount of increase of the retinal image, and, consequently, of visual acuteness by convex glasses.*

Let $hg^h = \beta_1$, Fig. 2, be the linear dimension of a smallest retinal image of an hyperopic eye, and $hi = \beta_2$, the retinal image of the same object in the same distance when looked at through a convex glass, then β_1 and β_2 constitute corresponding lines in two similar triangles, and are to each other as their distances from the corresponding nodal points. The quantity by which the second nodal point is shifted on the axes may be called $\delta = k_2^e\, k_2^h = k_2^e\, k_2^m$, then $hk_2^e = F_1 - \delta$, since the distance of the second nodal point of the compound system from the retina is equal to the first focal length of the eye, $hk_2^h = F_1$. We therefore obtain the following proportion:—

$\frac{\beta_2}{\beta_1} = \frac{F_1}{F_1 - \delta}$, from which is deduced

$\beta_2 = \frac{\beta_1 F_1}{F_1 - \delta}$.

If we give β_1 the standard value 1, we obtain

$\beta_2 = \frac{F_1}{F_1 - \delta}$ as the amount of β_2 with regard to β_1.

F_1 being 14,858 mm., and $\delta = 1{,}0909$ mm. (for + 10 as we saw above), we obtain

$\beta_2 = 1{,}0793$, *as the co-efficient of any retinal image, when + 10 is worn half an inch before the eye.*

If we measure visual acuteness by the smallest perceptible retinal image, and assume the hyperopic eye had S = 1, it will have S = 1,0793 when armed with + 10.

Since the linear dimension of the retinal image is in simple inverse proportion to the distance of the object, that is, decreases as the object is removed, Sn. xx. must be $1{,}0793 \times 20' = 21{,}580'$ removed from an eye armed with + 10 in order to produce the smallest perceptible retinal image.

(*B.*) *Calculation of the amount of diminution of the retinal image, and, consequently, the visual acuteness, by concave glasses.* In the unaided myopic eye the second nodal point lies in the same place as in the emmetropic eye, k_2^e Fig. 2. Since the retina is distended proportionately to its retrocession, the retinal elements contained in the line eg^e of the emmetropic eye are distributed over the longer line mg^m of the myopic eye. The retrocession of the second nodal point from k_2^e to k_2^m, resulting from the ad-

dition of a concave glass before the eye, generates from the same object which in the unaided myopic eye produced the image mg^m, now the smaller image mn. The relation of magnitude of both these images is easy to ascertain. $m k_2^m$ is equal to $F_1 = 14{,}858$ mm., and $k_2^m k_2^s = \delta$ is the retrocession of the second nodal point, amounting for a glass of 10″ of negative focal distance to 1,0909 mm. If $mn = \beta_2$, and $mg^m = \beta_1$, the similarity of the respective triangles shows

$$\frac{\beta_2}{\beta_1} = \frac{F_1}{F_1 + \delta} = 0{,}9316,$$

which expresses the co-efficient of the diminishing power of concave 10″.

A myopic eye, armed with $-10''$, therefore, must be considered to possess normal acuteness of vision, if it is able to read Sn. xx. at $0{,}9316 \times 20' = 18{,}632'$.

I have disregarded, in the foregoing investigations, the appearance of dispersion circles, and was certainly justified to do so, because I founded the visual acuteness on the density of the percipient retinal elements and the *dimensions* of the retinal images, making abstraction of all imperfections of the latter. If an unaided ametropic eye looks, with relaxed accommodation, at a distant object, the centres of the dispersion circles from the end-points of the object will fall on the same retinal elements as in the emmetropic eye, as is illustrated in Fig. 2 ; g^h, g^e, and g^m are the same retinal elements, that is, they are separated from the central element of the fovea centralis (h, or e, or m) by an equal number of intermediate elements. If

$e\,g^e$ are two adjoining retinal elements, then hg^h and mg^m are likewise adjoining.

The addition of spectacles to the eye has the effect of shifting the second nodal point on the axis. Hence the images of all the object points, except the one situate in the axis, are displaced, namely, removed from the axis by convex glasses, approximated to it by concave glasses. Thus it is evident that convex glasses cause the image of an object to cover a greater number of percipient retinal elements than if the same object were seen without glasses, whilst the inverse obtains with concave glasses. I have shown already that it is erroneous to speak, as it is generally done, of an augmentation or diminution of the visual angle by spectacles, for the visual angle remains unchanged, if glasses are worn at the usual distance of half an inch from the eye.

I have now, in a general way, solved the problem to show what influence spectacles have on the optical constants of the eye, on the size of the retinal images, and on the acuteness of vision. I have, moreover, illustrated it by an example, No. 10 convex and concave.

To render these investigations useful for reference, I shall tabulate the results of calculation concerning the series of our test-glasses :—

Number of glass in Paris inches.	Displacement of 2d cardinal points in millimetres.	Co-efficient of magnifying effect of convex glass.	Co-efficient of diminishing effect of concave glass.	S being 1, No. xx. Sn. should be read with convex glass in Paris feet,	S = 1, No. xx. Sn. should be read with concave glass in Paris feet
30	0,3628	1,0250	0,9762	20,50	19,52
16	0,6812	1,0480	0,9562	20,96	19,12
10	1,0909	1,0793	0,9316	21,59	18,63
8	1,3636	1,1011	0,9159	22,02	18,32
7	1,5584	1,1171	0,9051	22,34	18,10
6	1,8182	1,1396	0,8910	22,79	17,83
5	2,1818	1,1721	0,8720	23,44	17,44
4	2,7272	1,2248	0,8449	24,45	16,90
3½	3,1168	1,2655	0,8265	25,31	16,53
3	3,6363	1,3240	0,8034	26,48	16,07
2½	4,3636	1,4159	0,7738	28,32	15,48
2	5,4544	1,5800	0,7315	31,60	14,63
1¾	6,2499	1,7260	0,7078	34,52	14,08
1½	7,2914	1,9625	0,6708	39,25	13,42
1¼	8,2602	2,3044	0,6427	46,09	12,85
1	10,909	3,4878	0,5837	69,77	11,67

Remarks on the foregoing Table.

The displacement of the second cardinal points, that is, the second principal, nodal, and focal points, expresses at the same time the elongation or shortening of the ocular axis in degrees of ametropia corresponding to the number of the spectacle-glasses enumerated in the first column. The length of the ocular axis, that is, the distance between the apex of the cornea and the fovea centralis retinæ, in the normal eye, is 22,23 mm., according to *Listing's* diagram. We may, therefore, avail ourselves of this table to determine, with the ophthalmoscope or functional testing, the situation of any part of the fundus oculi with regard to the position of the posterior

focal plane. If, for instance, a tumor or a circumscribed exudation projects over the background of the eye, we have first to ascertain with which auxiliary glass, put behind the ophthalmoscope, we can see clearly, by relaxed accommodation and in the upright image, the background of the eye, and, secondly, with which other glass we can see the summit of the projection. The difference of both glasses will give the height of the elevation by referring to the first and second columns of our table. Since this evaluation is of importance in judging the existence and amount of any elevation or depression, as well as its augmentation or diminution during the course of the disease, I shall illustrate the manner of this ophthalmoscopic measurement by some examples.

1. In an emmetropic eye, the fundus of which an emmetropic observer sees distinctly without any auxiliary glass put behind the ophthalmoscope, and an ametropic observer with his neutralizing glass, there is a circumscribed exudation or tumor, the summit of which is distinctly seen in the erect image with all the convex glasses up to number 8, whilst with stronger glasses it appears indistinct. Then No. 8, the strongest convex glass with which the summit of the tumor appears distinct, indicates an elevation of the tumor by 1,36 mm. over the background of the eye, as is seen by the number of the second column of the above table corresponding to No. 8.*

* I have described this method of estimating the relief of the background of the eye at the meeting of the Société Universelle d'Ophthalmologie, Aug., 1867, in Paris, and given a table relating to it in my book on "Intraocular

2. The fundus oculi is seen with + 24 distinctly, the summit of a tumor with + 4. The height of the tumor is calculated as follows: $\frac{1}{4} - \frac{1}{24} = \frac{5}{24}$, or nearly $\frac{1}{5}$. No. 5 in the first column of the above table indicates, as seen in the second column, an elevation of 2,18 mm. over the level of the retina.

3. The fundus is seen distinctly with − 20; the summit of a tumor with + 10. $\frac{1}{10} + \frac{1}{20} = \frac{3}{20} = \frac{1}{6\frac{2}{3}}$ gives, with reference to columns the first and second, 1,66 mm. as the height of the tumor.

4. A hyperopic eye, the retina of which appears distinct with + 6, suffers from chronic glaucoma. The area of the optic disc appears plain with + 18. How deep is the excavation? $\frac{1}{6} - \frac{1}{18} = \frac{1}{6}$. Answer: 1,2 mm. This method of estimating elevations and depressions is especially valuable in the early stages of new growths and excavations, when the differential diagnosis and our judgment with regard to the progressiveness of the morbid action are apt to be difficult.

The *third and fourth columns* of the above table do not require much explanation. Each glass of the first column,

Tumors," p. 106. The numbers there were obtained by another way of calculation, and differ slightly from those given in this paper, because I took as basis of the former calculation the results of my own measurements on the living eye, whilst for the calculation of the present table the values of *Listing's* diagrammatic eye are taken as basis. I have here preferred *Listing's* values, although they are perhaps not so generally correct as those obtained on the living eye, because they are at the reach of everybody, and the difference between the two is unimportant. Dr. *Mauthner* also describes the measurement of the depth of the background of the eye in his Treatise on Ophthalmoscopy, Vienna, 1868. He gives some examples, but no table to refer to.

by displacing the second nodal point, produces a certain alteration of the size of the retinal images. This alteration is found by multiplying the linear dimensions of the retinal images with the corresponding numbers of the third and fourth columns. Therefore I have called them *co-efficients* of the magnifying or diminishing effect of spectacles.

The *fifth and sixth columns* need not much explication either. Snellen's test-types being so chosen that the size of the letters or the intervals between them produce, at the distance indicated by their numbers, the smallest perceptible retinal images, then by looking with spectacles, on account of their magnifying or diminishing power, the distances of the types from the eye must be changed, if the images are to remain the smallest possible for distinct perception. We find the requisite distance for each number of Snellen's test-types, and for each spectacle-glass, by multiplying the number of the type with the co-efficient of magnifying or diminishing power of the glass. This having been done for No. xx with the series of test-glasses, the fifth and sixth columns give a comprehensive statement of the influence of spectacles on the acuteness of vision. We see that spectacles weaker than number ten have but a slight influence on the distance in which the different types should be read, so that we may fairly neglect it. Stronger glasses than No. 10 have a notable influence on the distance in which the type ought to be read. This influence, however, is not so great as might perhaps be an-

ticipated, since of strongest convex glasses No. 2 requires only one and a half of the distance indicated by the number of type, No. 4 nearly $\frac{5}{4}$ of it, etc., whilst concave glasses No. 2 require only $\frac{3}{4}$ of the distance stated in the number of type, in order to let visual acuteness appear normal.

I think it is not practical to change anything in our accustomed annotations of visual acuteness. But when it is of importance to judge exactly of the acuity of vision, we may refer to the above table which will in a moment give us the correction to be made in our annotations. Say, for instance, a myopic eye can read with number two Sn. xx at 15′, then we would note it as follows: M$\frac{1}{2}$, S$\frac{15}{xx}$. A look at column the sixth of our table will show us immediately that S in this case is not $\frac{3}{4}$, but 1. The use of the table for reference appears to me so simple, that I think it unnecessary to give any further examples.

(B.) INFLUENCE OF SPECTACLES ON THE APHAKIAL EYE.

The optical system of the *aphakial eye*—which means an eye whose crystalline lens has been removed, or dislocated, or absorbed—is essentially different from that of the emmetropic eye. As clear vision in aphakial eyes can only be brought about by the help of strong convex glasses, I shall now proceed to investigate what influences such glasses exert on the optical system and visual acuteness of aphakial eyes. In noting, at the present day, the results of our cataract-operations, we

do no longer content ourselves by the general expressions that good or useful vision was obtained, or even that sight was regained, but we test the acuteness of vision in quite as rigid a manner as we do in ordinary eyes. To know the alterations which spectacles produce in aphakial eyes, is, therefore, not merely of theoretical, but of practical interest.

I shall determine the optical constants of armed aphakial eyes in the same manner as I did those of armed emmetropic eyes.

The *optical constants of the unarmed aphakial eye* which constitute the second system, are the following:–

ϕ_1, the first focal distance, is = 23,692 mm.

ϕ_2, the second focal distance, = 31,692 mm.

Both the principal points coincide, and are situate in the apex of the cornea.

Both the nodal points coincide likewise, and are situate in the centre of curvature of the anterior surface of the cornea, namely, 8 mm. behind its apex.

These values are borrowed from *Listing's* diagrammatic eye, in conformity with our former inquiries into the optical constants of armed emmetropic eyes. The first optical system is represented by the convex glass lens, the principal and nodal points of which, here too, may be assumed with sufficient accuracy to coincide with its optical centre. We admit that the latter is placed 12 mm. in front of the eye. This, therefore, is the mutual distance—called *d*—of the principal points of the first and second systems.

Helmholtz's formula 11*d*, $h_1 = \frac{d\,f}{d - \phi_1 - f}$, will serve to calculate the position of the first principal point of the compound system in front of the first principal plane of the first single system. Applied to lens + 3, that is, of 81,21 mm. of positive focal distance, it will result in

$$h_1 = \frac{12 \times 81{,}21}{12 - 23{,}692 - 81{,}21} = -\ 10{,}485 \text{ mm.},$$

which means that the first principal point of the compound system lies 10,485 mm. *behind* the glass. Since the latter is placed 12 mm. in front of the cornea, the first principal point of the compound system lies 1,515 mm. in front of the cornea.

Formula 11*e*, $h_2 = \frac{d\,\phi_2}{d - \phi_1 - f}$, determines the position of the second principal point of the compound system behind the cornea. It results for lens + 3 in $h_2 = -\ 4{,}0917$ mm. The − sign signifies that h_2 lies in front of the cornea, and, as follows from the position of h_1, 2,5767 mm. before the first principal point of the compound system. The latter number denotes at the same time the distance between both the principal points, therefore also that between both the nodal points of the compound system. For lens + 3, therefore, $H_1\,H_2 = K_1\,K_2 = 2{,}5767$ mm.

The position of the *first focal point* of the compound system in front of the optical centre of the glass lens is obtained by formula 11*a*, $a_1\,t_1 = \frac{(d - \phi_1)\,f}{d - \phi_1 - f}$. For lens + 3 this is found by calculation =10,216 mm. If we add 12

mm. as the distance of the glass from the cornea, we obtain the position of the first focal point of the compound system in front of the cornea, namely, 22,216 mm. Since, however, the first focal length is reckoned from the first principal point, we must deduct 1,515 mm. from that quantity, and we obtain the anterior focal length of the compound system $F_1 = 20{,}701$ mm.

The position of the *posterior focal point* behind the second principal plane of the second system—in our case the anterior surface of the cornea—is determined by formula 11*b*, $\alpha_2\, t_2 = \dfrac{(d - f)\,\phi_2}{d - \phi_1 - f}$. By inserting the proper values, we find for lens + 3 $\alpha_2\, \tau_2 = 23{,}599$ mm. It is evident that this number represents at the same time the length of the AXIS OF AN APHAKIAL EYE which sees at distance best with + 3. As, however, the posterior focal length is measured, not from the cornea, but from the second principal point, we must add to this quantity 4,0917 mm., the distance in which the second principal point of the compound system is situate in front of the cornea. Thus we obtain $F_2 = 27{,}691$ mm.

The positions of the two *nodal points* of the compound system are easily found out by the following considerations :—The distance between the second nodal and the posterior focal points is equal to the first focal length. Therefore $F_2 - F_1 = H_2\, K_2$, that is, the distance between the second principal and second nodal points, which is also equal to $H_1\, K_1$, the distance between the first principal and first nodal points. For lens + 3 $H_1 K_1$, or $H_2 K_2$, is equal

to 6,990 mm. Since the first principal point lies 1,515 mm. before the cornea, we must deduct this quantity from 6,990, to find the position of the first nodal point behind the cornea. We obtain 5,475 mm. The position of the second nodal point is found in a similar way by deducting from 6,990 mm. the distance of the second principal point from the cornea, which amounts to 4,092 mm. We obtain K_2 lying 2,898 mm. behind the apex of the cornea.

In this way all the optical constants of an aphakial eye armed with + 3 are determined.

Let us now inquire *what influence spectacle glasses exert on the visual acuteness of aphakial eyes.*

We assume that the eye, before it was deprived of its crystalline lens, possessed normal visual acuity. The position of its retina, that is, the length of its antero-posterior axis, can be determined, after its lens has been removed, by formula 11*b*, as we have seen. Since we know the optical constants in the aphakial state, we can calculate the

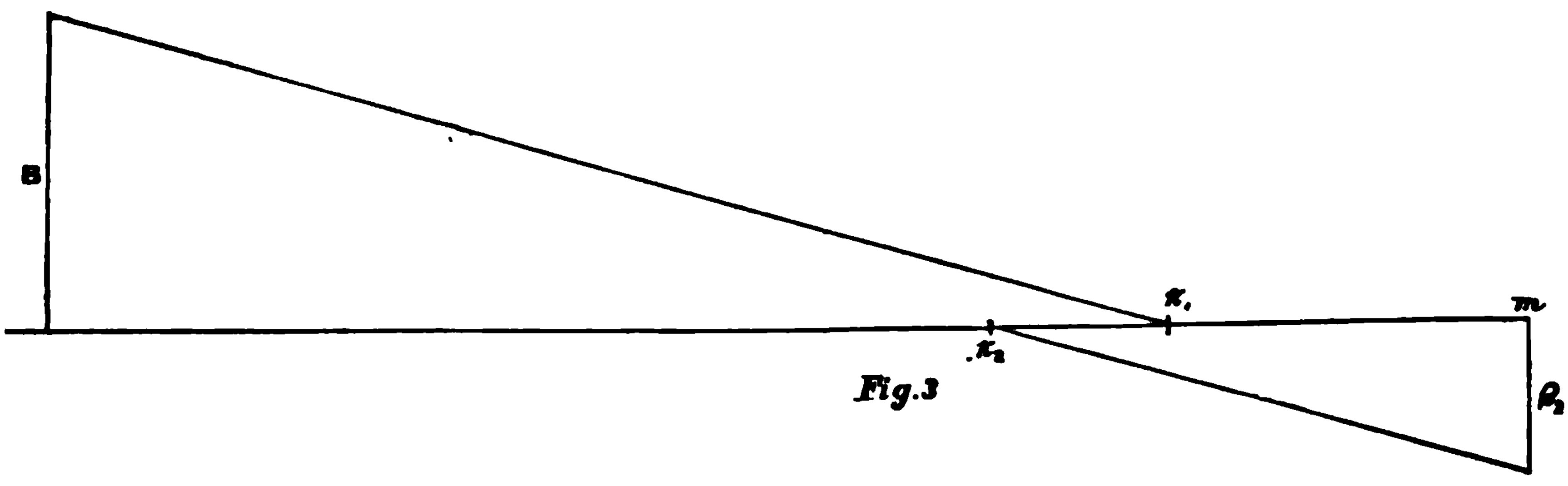


Fig. 3.

size of the retinal image of any visual object. B, in Fig. 3, may represent a small remote object which the apha-

kial eye, armed with + 3, is able to see distinctly. The one of its end-points may be situate on the optical axis of the eye. The line of direction of its other end-point is, in its course through the air, directed to the first nodal point K_1, and passes, in its course within the vitreous body, through the second nodal point K_2, while remaining parallel to its first section in the air. Thus the retinal image β_2 is defined. If we now imagine the same eye to be still in possession of its normal crystalline lens, we may draw in it the retinal image of the same object seen in the same distance. Since cornea and lens are assumed to be normal, the optical constants of *Listing's* diagrammatic eye may be used for the determination of the retinal image. Fig. 4 may illustrate this. To find out the

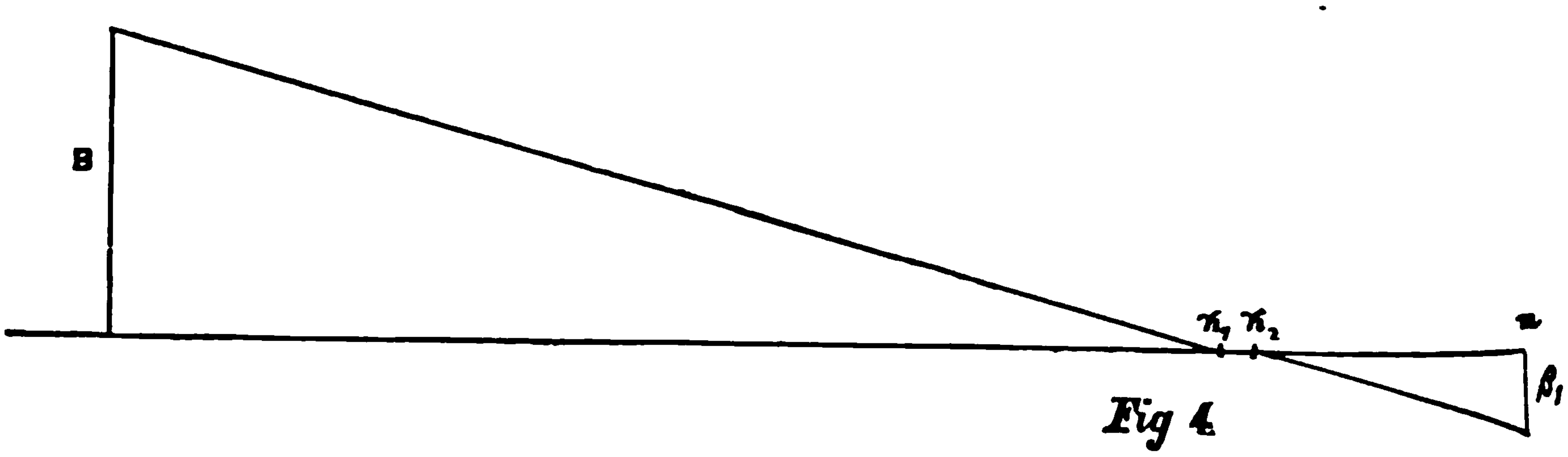


FIG. 4.

magnifying effect of the glass lens, we have to compare the sizes of the retinal images β_2 and β_1 formed, in both eyes, of the same object B. The triangles formed by the retinal images and their connecting lines with the posterior nodal points being similar to each other, the sizes of both images are to each other as their distances from the

second nodal points. $\frac{\beta_2}{\beta_1} = \frac{m\ K_2}{m\ \varkappa_2}$. If we attribute to β_1 the value 1, then $\beta_2 = \frac{m\ K_2}{m\ \varkappa_2}$. The quantity mK_2 is known, and equal to the anterior focal length F_1 of the lensless eye when armed with + 3. The quantity $m\varkappa_2$ may be called ϕ, and determined as follows. We found the axis of this eye equal to 23,599 mm. The posterior nodal point is situate 7,373 mm. behind the cornea. ϕ, therefore, is equal to 23,599 − 7,373 = 16,326 mm. We obtain, consequently, $\beta_2 = \frac{F_1}{\phi} = \frac{20{,}701}{16{,}326} = 1{,}2758$. This is what we have called the co-efficient of the magnifying effect of the glass lens. The distance at which any number of Snellen's test-types ought to be read by a lensless eye, when armed with + 3 and endowed with normal visual acuteness, is obtained by multiplying this co-efficient with the number of the type, for instance, No. xx should be read in 20 × 1,2758 = 25,52 feet.

In this consideration we have presupposed that the lines of direction emanating from the end-points of the same object, which has to remain at the same distance, are parallel, and this supposition may be made with sufficient accuracy. The letters of Sn. xx are 9,5 mm. high, they are seen at a distance of 20′, that is, 6496,9 mm. The first nodal point of the emmetropic eye lies 6,957 mm. behind the cornea, that of the aphakial eye, when armed with +3, lies 5,475 mm. behind the cornea. If from an elevation of only 9,5 mm. above a straight

basal line, other straight lines are drawn to two points of the same basal line at a distance of 6497 mm. from the point of origin, and only 0,3 to 3,0 mm. from each other, these lines will be sufficiently parallel to each other for all ordinary purposes. To satisfy myself of this fact, I have calculated the visual angles formed in emmetropic eyes and armed aphakial eyes by letters of Sn. xx seen at 20′. If we call the visual angle v, its tangent will be, in the emmetropic eye, $\frac{9,5}{9503,9}$, and in an aphakial eye, when armed with +4, = $\frac{9,5}{6503,0}$. The logarithms of the tangents of these angles differ only in the fifth decimal, and show in both cases an angle of five minutes. This angle remains the same also for the strongest lens, + $1\frac{1}{2}$, that may ever be put before an aphakial eye. The logarithms of the tangent of its visual angle and that of the emmetropic eye differ by 0,00022, whilst the difference of the logarithms of the tangents of an angle of 5 minutes and 0 second, and those of an angle of 5 minutes and 1 second is 0,00134. From the foregoing considerations it ensues *that the movement of the first nodal point by spectacle glasses exerts no appreciable influence on the size of the smallest visual angle* as used in our common test-types, since its greatest movement, produced by + $1\frac{1}{2}$, causes a change in the size of the visual angle not exceeding $\frac{1}{6}$ of a second.

Thus far I have shown, in a general way, and illustrated by an example, what alterations are brought about in the optical system of aphakial eyes armed with spec-

tacles. I have demonstrated, moreover, what influence spectacles have on visual acuteness when the latter is tested in the manner now in general practice. Since both the changes of the optical constants and of visual acuteness deserve to be known, I have calculated them for the usual cataract glasses; and collected them, for the sake of reference, in the subsequent table.

The letters at the heads of the columns have the following meaning:—

No = focal length of glass in Paris inches.

F_1 = first focal length of aphakial eye armed with lens named in first column.

F_2 = second focal length of compound system.

Ax = Axis of aphakial eye requiring for distant vision lens indicated in first column.

$H_1 K_2$ = distance between first principal and first nodal points.

$H_1 H_2 = K_1 K_2$ = mutual distance of principal or nodal points.

H_1 = position of first, and H_2 of second principal point behind the cornea. A − sign indicates that they lie before the latter.

K_1 and K_2 = position of first and second nodal points behind the cornea.

Co-ef. = Co-efficient of magnifying power.

Sn. xx *in feet*, at what distance, in Paris feet, Sn. xx should be read when S = 1.

No.	F_1.	F_2.	Ax.	$H_1 K_1$.	$H_1 H_2$.
1½	18,300	24,596	17,324	6,296	4,536
1¾	19,080	25,525	19,193	6,445	3,996
2	19,485	26,063	20,286	6,578	3,646
2½	20,202	27,024	22,232	6,802	3,024
3	20,701	27,691	23,599	6,990	2,577
3½	21,089	28,210	24,637	7,121	2,254
4	21,384	28,605	25,435	7,221	2,001
5	21,809	29,172	26,586	7,363	1,632
6	22,113	29,565	27,381	7,452	1,389

No.	H_1.	H_2.	K_1.	K_2.	Co-ef.	Sn. xx. in feet
1½	— 2,736	— 7,2720	3,560	—0,976	1,8390	36,78
1¾	— 2,336	— 6,3316	4,109	0,113	1,6149	32,30
2	— 2,131	— 5,7769	4,447	0,801	1,5124	30,25
2½	— 1,768	— 4,7917	5,034	2,010	1,3595	27,19
3	— 1,515	— 4,0917	5,475	2,898	1,2758	25,52
3½	— 1,318	— 3,5730	5,803	3,549	1,2216	24,43
4	— 1,169	— 3,1700	6,052	4,051	1,1839	23,68
5	— 0,954	— 2,5864	6,409	4,777	1,1351	22,70
6	— 0,795	— 2,1843	6,657	5,268	1,0801	21,60

LARGE CYST OF THE IRIS, CURED BY OPERATION.

By H. KNAPP.

The literature of cystic tumors of the iris is yet very fragmentary. *J. W. Hulke* (Ophth. Hosp. Rep., Vol. VI., 1, p. 12) and *L. Wecker*, in his Études Ophthalmologiques (I., p. 426), and in a paper in these Archives (I., 1, p. 85), have given the fullest accounts of what is known on this subject. Since especially the clinical part of cystic tumors originating in the iris is as yet most defective, I think that the description of the following case may not prove destitute of interest and practical utility.

Cecile *Delahaye*, from Burlington, Iowa, eleven years of age, was injured, eighteen months ago, with a knife, the point of which entered her left eye just at the corneo-sclerotic juncture. The pupil became pear-shaped, the sight, for some days impaired, returned nearly as good as that of the other eye. A black, elevated spot at the seat of the wound was always visible. The eye was free from pain and annoyance. Eight months ago, however, the father observed that a thin gray membrane had formed in the eye directly under the scar, and was grad-

ually increasing in the direction of the pupil. Four months ago he perceived that a similar membrane developed itself on the other side of the pear-shaped pupil. Both were growing steadily, and slowly approached each other, until they coalesced, assuming a heart-shaped figure. The sight had been impaired, and the eye, of late, became from time to time red and painful.

The patient, a tall healthy girl, presented herself to me on the 31st of May, 1869. Her right eye was normal in appearance and functions, and had never experienced any alteration. The left showed some episcleral injection, most marked towards the nose. On the sclerotic border, a little inward from the upper end of the vertical corneal meridian, was a small bluish elevation of three millimetres in length and two millimetres in breadth (*a* Fig. 5). Through the normal cornea a

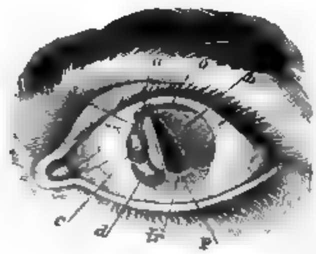


FIG. 5.

transparent cyst was, at first glance, visible, filling the upper four-fifths of the anterior chamber. It left a small piece of healthy iris, on the lower part of the chamber

(*ir*), uncovered, and about a quarter of the normal size of the pupil was free and perfectly black (*p*).

The *cyst itself* appeared as a transparent, homogeneous, somewhat grayish bag, filled with clear water. The coloboma and iris could be seen through it. The whole anterior surface of the cyst appeared to be in immediate contact with the cornea, whilst its inferior border was round, and formed an angle in the pupil (*a*). Its upper and outer part lay upon the iris, which it pushed backward (*b*). The surface of this part of the iris, visible through the cyst, displayed a grayish discoloration, but was smooth, with quite a regular pupillary edge. On the upper corneal margin there existed a small, slit-shaped iridodialysis (*o*, Figs. 5 and 6). Entirely different was that portion of the iris bordering on the inner side of the coloboma. It was very much pushed backward, and showed two cup-like depressions (*c*, *d*), each of which was confined, inferiorly, by a curved projecting ridge of iris tissue. The lower of them formed the boundary of the preserved healthy part of the iris. The surface of the depressed portion of the iris appeared dirty gray, and even black in the upper part, which also exhibited the deepest cup. The pupillary edge was elevated, forming, along the whole inner border of the coloboma, a septum (*s*) with antero-posterior direction slightly bulging towards the coloboma. Its margin did not reach the posterior surface of the cornea, but was overlapped by the outer portion of the cyst. Inward from the coloboma, especially in the upper cup, the tis-

sue of the iris appeared rarefied, and the black pigment of the uveal layer became visible through the cyst.

My opinion was that this cystic tumor had its origin in that portion of the tissue of the iris which was involved in, and attached to, the corneo-scleral cicatrix. It had first grown within that portion of the iris which lay inward from the coloboma. Its anterior wall soon projected over the anterior surface of the iris, extended, in its upper part, over the pupil and the outer portion of the iris, and became so much filled that it touched the posterior surface of the cornea, and crowded the iris and lens backward. The tumor was evidently still progressive.

All the cysts of the iris which have been recorded up to this day (about 22 in number) *were, when left untouched, destructive to the eye, and several of them even caused sympathetic inflammation of the other eye.* I therefore was convinced that nothing but an early operation could save the eye of the patient, and my opinion was confirmed by further examination.

The eye was painful to the touch, exhibited a manifest increase of tension, which remained unvariable during the four following days. $S = \frac{1}{25}$. $M = \frac{1}{14}$. The other eye was emmotropic; the O S revealed nothing remarkable in the fundus of either eye, especially no staphyloma posticum of the left. The myopia of this eye was surprising, in consideration of the fact that iris and lens were considerably pushed backward, which condition of itself evidently would have rendered the eye hyperopic.

This, however, did not take place, but just the contrary, which may be explained in the following way. The cyst pressed forcibly on the lateral portions—except the lower one—of the lens, and thereby caused a bulging of that portion of the anterior lens surface which was not covered or pressed upon by the tumor. A circumscribed augmented convexity of the anterior capsule must have been produced to such a degree as not only to counterbalance the optic effect of the retrocession of the lens, but even to cause considerable myopia.

The nature of the disease, and the painfulness, increased tension, and impaired sight of the eye, forced the unswerving conviction upon me that the eye was sure to be destroyed unless the growth of the cyst were checked. To expect this from anything else but an operation, could not be thought of. Puncture of the cyst would surely have been followed by a recurrence. The removal of the whole cyst seemed impossible without rendering the operation too perilous by the extent of the wound. I therefore concluded to take away as much of the tumor as I could without exposing the eye to a greater danger than is borne safely in ordinary operations. If a recurrence should follow, I imagined, then the incipient state of the refilling cyst would show a tumor smaller and easier to remove totally by a subsequent operation. I operated in the following way. With a broad lance-shaped knife I made an incision at the inner side of the corneo-sclerotic juncture, near the corneal margin, but within the sclerotic border. The inner portion of the

cyst, of course, was penetrated and emptied by the knife. Introducing a pair of delicate iris-forceps, and trying to seize that piece of the cyst which lay over the pupil and the outer part of the iris, I found an insurmountable obstacle in the vertical septum (*s*, Fig. 5). I therefore seized the latter by widely opening the branches of the forceps, and, after closing them, I had the pleasure of seeing the whole inner part of the iris come out. Cutting it off close to the wound produced a wide coloboma, in which none of the inner part of the iris remained behind. The condition of the eye, after the operation, is represented in Fig. 6. The uncovered part

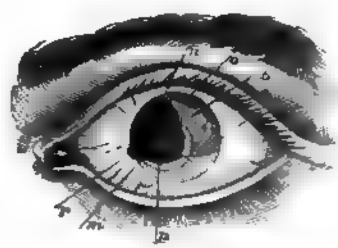


FIG. 6.

of the pupil, which before the operation had been small and triangular (*p*, Fig. 5), had enlarged to a broad stripe, reaching the inner margin of the cornea (*p*, Fig. 6). The broken wall of the outer cyst still covered the outer part of the iris (b), and its lower border (*m*, Fig. 6) stretched across the upper pupillary space nearly as far as the inner corneal margin. In seizing the septum I had caught hold of the overlapping portion of the outer

cyst, and dragged it necessarily towards the wound, in which, however, it was not involved.

A moderate degree of irritation followed the operation. Tolerably well marked circumcorneal injection, and some swelling of the border of the upper lid on the following day, were symptoms not altogether pleasant, but they were counterbalanced by the total absence of pain, and normal appearance of the lower part of the iris. I abstained, therefore, from any severer treatment. The eye recovered very rapidly. Ten days after the operation a slight protrusion of iris in the corner of the scar of the iridectomy wound was noticeable, which increased somewhat during the following days, representing a condition which we not infrequently see after large excisions of the iris in operations for glaucoma or extraction of cataract. The sight of the eye was greatly improved, the tension of the globe lessened, but in the upper part of the pupil there seemed to be a renewed and circumscribed swelling (*n*, Fig. 6) of the cyst, the walls of which, up to that time, had lain shrivelled up and flat upon the lens and outer part of the pupil, the anterior chamber having been, soon after the operation, fairly re-established. Since this swelling threatened to cause a refilling of the cyst, and in any case darkened a considerable part of the pupillary field, I decided to remove it, if possible, together with as much of the adjoining part of the iris as I could, by another outward and upward iridectomy. After having made a broad incision at the upper and outer corneal

margin, I introduced a blunt (Tyrell's) hook in front of the iris and remaining part of the cyst, as far as to bring the point of the instrument behind the inner edge of the cyst. I grasped with the hook the peripheral portion of the cyst near the point *m*, and proceeded to draw it out in the direction towards *b* (Fig. 6), together with the iris beneath it. At first the cyst followed nicely, separating itself from the capsule of the lens, but its attachment to the upper part of the primary coloboma and to the scar did not give way, so that the tissue of the cyst was ruptured, and only the middle portion of it extracted and cut off with the iris. By means of forceps and a sharp iris hook I attempted, with great care not to wound the lens-capsule, further to remove the upper and lower remnants of the cyst, but succeeded only partially. After having done this, I excised the small prolapse of iris in the corner of the first iridectomy wound (*r*, Fig 6). The operation was followed by no pain, but the globe became red, and the upper lid swelled. No remedy was administered except atropine. The eye recovered rapidly from the operation, sight improved, and the small remnants of the cyst shrivelled up, resembling patches of connective tissue. A week after the operation the very lively young patient, having been imprudent in walking, and eating more ice-cream than was good for her, felt feverish and sick, and vomited several times. She had some pain in her eye, and an abundant running of tears. I did not see her till the following day, and found the eye red again, the anterior chamber quite empty, and the

iris greenish discolored. I ordered six leeches to be put in the temple, and kept her in bed for two days, having atropine dropped into her eye every hour. The iritis at once subsided, the anterior chamber slowly refilled, the visual field, which had become densely clouded, cleared up again, and at the end of five days the consequences of this inflammatory attack had disappeared. A week later, that is, three weeks after the second, and five after the first operation, the patient returned home, her eye being in the following condition. It was still very sensitive to brilliant light. Vision $\frac{1}{10}$, having been $\frac{1}{35}$ before the first operation. The *myopia had disappeared.* She could read Sn. CC at 20′ distance, and said that concave glasses made the letters no clearer, whilst convex glasses made them blurred. F was normal, and T no longer increased. Subconjunctival vessels were still somewhat injected. The cicatrix from the first iridectomy showed again a small prolapsus iridis in the

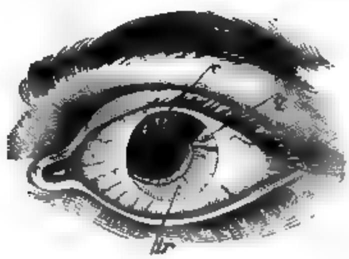


FIG. 7.

lower corner, and there seemed to exist some tendency to cystoid protrusion of the cicatrix. The second iridec-

tomy wound was firmly united; the outer surface of the cornea clear and sensitive; its inner surface, however, showed in its upper inner part (*c*, Fig. 7) some dark grayish spots, like connective tissue, probably the remainders of the shrivelled cyst having become attached to the cornea during the evacuation of the anterior chamber. The lower and outer portion of the iris (*ir*, Fig. 7) appeared quite normal, only the corner (*g*, Fig. 7) bordering outwardly on the coloboma was still covered by a delicate grayish membrane, being the last remnant of the cyst wall. The lens was transparent throughout, but some opacities upon the capsule had remained behind. It seemed to be somewhat pushed forward, the anterior chamber having not yet regained its natural depth. The interior of the eye could be well illuminated, but I was unable to distinguish the details of the fundus on account of the irritability of the eye.

I should have been glad to remove the last remnant of the cyst, together with the small part of iris beneath it, but at the second operation it was not possible to excise it without giving the wound such an extent as to endanger the eye. To take it away now, three weeks after the second operation, did not seem advisable either, since the endurance of the eye for further operations, as well as the patience of the little sufferer, appeared to be exhausted. Apart from this, the refilling of the cyst could not be predicted with any degree of probability. If it should occur, which was no more than a mere possibility, less supported by the analogy of similar observa-

tions than apprehended by our sympathizing care for the amiable young patient, an ultimate operation in order to take away the small remains of the cyst would not have been so perilous as either of the preceding ones.

I examined the pieces of iris and cyst which had been removed by the first operation. The iris had preserved its natural structure, showing no degeneration, but some degree of atrophy. Upon it lay the delicate cyst-wall, composed of flat, very large, polygonal epithelial cells.

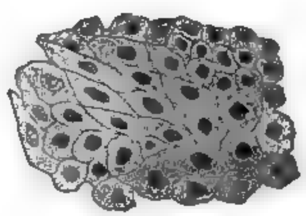


FIG. 8.

I could not make out a basement membrane between these cells and the iris, but a piece of the free wall of the cyst exhibited the parallel and winding lines characteristic of homogeneous membranes, for instance, the glassy membrane beneath the pigment epithelium of the choroid. Therefore it was evident that the *wall of the cyst consisted of a delicate homogeneous (glassy) membrane lined with pavement epithelium.* Its contents were entirely transparent and fluid, like water. They could not be gathered during the operation, although I tried to obtain them.

The origin of cystic tumors of the iris has been much discussed of late. There are three opinions on it:—

(1.) They are said to be the dilatation of pre-existing free spaces in the iris. (2.) They are regarded as new formations, a conclusive illustration of which is furnished by the highly interesting observation of *Von Graefe*, relative to a dermoid cyst in the iris containing atheromatous matter with short stiff hairs (Arch. f. Ophthalm., III., 2, p. 412, and ibidem, VII., 2, p. 39). (3.) They are supposed to develop by a process of sacculation in such a way that by adhesive inflammation, especially after penetrating wounds, the iris becomes attached to some part of the walls of the anterior chamber. If in such cases a free space between the attached parts is left, the secreted fluid will increase it to form a pouch, which by subsequent formation of a new wall will become a true cyst. This opinion, strongly advocated by *L. Wecker*, accounts best for the origin of the cyst in the case just described.

The unfavorable side of the *prognosis* of the latter depends upon the possibility that the last piece of the cyst left behind may become the starting-point of a recurrence, and besides that, in the predisposition for glaucoma in eyes with anterior synechiæ. A tendency to serous effusions is manifested in this eye by the cystoid cicatrix at the place of the primary injury, and, perhaps, by the small portion of iris involved in the lower angle of the first iridectomy wound. The large coloboma, however, and the youth of the patient, will, I suppose, counterbalance this tendency. As to the possibility of a recurrence, I think that what we know

on this subject does not speak for its probability, since iris cysts did not reappear even after simple paracentesis, or after removal of their anterior (free) wall, whilst in the case under consideration only a very small part of the cyst wall, and the iris beneath it, is left behind, but the bulk of the tumor, and all the iris with which it was connected, are taken away.

Since I wrote the foregoing, which was at the time of the patient's discharge, I have had repeated information with regard to her health. The eye has completely recovered, there is no irritability of either eye, and no cystoid protrusion of the wound has developed. The lower part of the iris is somewhat drawn upward, encroaching upon the clearest portion of the pupil; vision, however, so far restored that ordinary print can be read with the injured eye. This was the condition of the patient according to the latest information, which I received a few days ago,—seven months after the operation.

CASE OF EXTIRPATION OF A CANCROID GROWTH OF THE INNER CANTHUS AND UPPER EYELID. BLEPHAROPLASTY BY SLIDING FLAPS.

By H. KNAPP.

The unsatisfactory results obtained in many cases of blepharoplasty by transplanted flaps of skin, due to subsequent contraction and thickening, with very unpleasant consequences, induced me, during the last few years, to cultivate more the method of the *sliding of flaps.* My experience in this direction has been so far very encouraging. Two extremely satisfactory cases I have published a short time ago, the one in the "Arch. f. Ophthalm.," XIII., p. 180, etc., and the other in the first number of the Archives of Ophthalm. and Otology, p. 139.

The following case is analogical to the two preceding ones, but offers peculiarities with regard to the mode of operation which may prove useful in the treatment of similar difficulties:—

Sea-Captain M., of Scotland, 45 years of age, healthy

and robust, observed about two years previously a small, hard, circumscribed elevation in the skin of the upper eyelid and the inner canthus. It gradually increased, was surrounded by other nodules, and constituted, at the time when he came to me, August 23d, 1869, a nodular thickening of the skin upon and above the inner canthus (see Fig. A), twelve millimetres in breadth and thirty

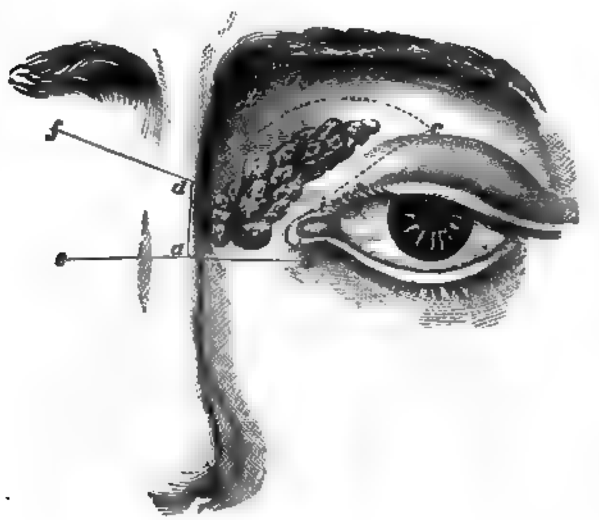


FIG. A.

in length. The tumor was felt by the exploring finger as a dense mass receding into the orbit, but without firm attachments to the bone. Since it presented all the qualities of a cancerous growth, the patient agreed at once to its removal by an operation, which advice had been already given to him by some other physicians.

I circumcised it by a curved and angular line fully

within the healthy skin (*a b c d*), and dissected it carefully and slowly through the healthy tissue of the orbit, guiding my steps always by the exploring forefinger of my left hand. The ligamentum canthi, being quite unaffected, could be spared, but above it I found the tumor penetrating into the orbit about half an inch, so that after its removal a considerable hole was visible. The inner portion of the cartilage of the upper lid had been taken away. The defect of skin which reached from below the inner canthus and the root of the nose obliquely upward and outward as far as the eyebrow, and a little beyond the middle of the upper lid, was covered by sliding flaps in the following manner:—A straight cut, *a e*, was made through the skin horizontally over the back of the nose, in prolongation of the lower border of the wound *a b*. Another straight cut, *d f*, went through the skin from the inner upper orbital angle towards the brow of the other eye. The flap comprised between these two lines was dissected from the original wound towards its basis, which lay on the other side of the nose. Next I dissected the inner portion of the lower lid, *b*, from the subcutaneous tissue of the conjunctiva, and separated, to the extent of some lines, the skin of the upper lid along the wound *b c* from the orbicularis muscle and cartilage. I then united the lower end, *a*, of the nasal flap with the inner end, *b*, of the lower lid, which caused considerable stretching of the latter and the flap. The lower border of the flap was united by silk sutures with the adjacent skin without marked puckering of the latter. Then the

inner part, *i*, of the upper lid was fastened to the opposite border of the nasal flap. The wound now looked as represented in Fig. B. A simple stitching together of the

FIG. B.

upper lid and the nasal flap could not be thought of, because it would have occasioned a very disfiguring ectropion. To make a cut through the upper lid, parallel to the margin of the lid, and shifting the latter towards the nose as far as to reach the flap, was quite impracticable, because the tendon of the levator muscle must be preserved lest incurable ptosis be the consequence. For this reason the method which I have very successfully applied to the lower lid, is not applicable to the upper. To obviate both these difficulties, ectropion and ptosis, I made a vertical cut, *n m* (Fig. B), from the

inner upper angle of the wound, about three-quarters of an inch in length. Now I dissected off the skin situate above the wound, and fitted the angle *m n c* into the angular defect *d i c* (Fig. B), uniting the edge *n c* with *i c*, and the lower part of *n m* with the upper part of the vertical margin of the nasal flap. The remaining small triangular defect, *d n m* (Fig. B), was covered by loosening from its base the triangular flap of skin *m n f*, lying above the quadrangular nasal flap, and by uniting its edges with the opposite edges of the remaining triangular defect.

Fig. C.

In this manner the whole wound was closed, and the region of the operation had the appearance which is represented by Fig. C. Both eyelids were stretched

towards the nose, a slight degree of eversion of the inner margin of the upper lid existed, and the transplanted portions of skin, now situate over the inner canthus, stretched over a hollow space, the former seat of the orbital portion of the tumor. I considered this hollow space a favorable condition, presupposing that the cicatricial tissue which was to fill it up would draw the skin bridging loosely over it, backward into the orbit. This expectation was fully realized. There was but trifling suppuration in this space. The whole wound healed by first intention, and the slight degree of eversion of the inner portion of the upper lid entirely disappeared, in consequence of the retraction of the cicatrized tissue near the inner canthus. The upper lid was perfectly movable, and the palpebral fissure closed easily at will and during sleep. Epiphora was the only thing the patient had to complain of. The interference with the canaliculi and the removal of the m. compressor sacci lacrymalis were the unavoidable cause of this not very material annoyance.

About a fortnight after the operation the patient was presented to the Medical Society of the County of New York, when he was examined by the scrutinizing eyes of the most experienced surgeons of the metropolis, who pronounced the result of this blepharoplasty as the most satisfactory that could have been obtained. A week afterwards the patient went on board ship again, and, four months later, he wrote to me that his eye continued

in excellent condition, showing no disfigurement or annoyance, except simple lachrymation.

On *microscopic examination* I found in the specimen the ordinary structure of epithelioma. Its peripheral portions were very vascular, and consisted mainly of smaller epithelial cells densely interspersed with lymph corpuscles, which penetrated also in large quantities into the neighboring connective tissue of the orbit. The epithelial cells of the growth were accumulated by homogeneous juxtaposition, presenting but rarely the well-known cone-like figures. In some places the large epithelial cells were very distinctly *serrated* (Stachelzellen), and, with an immersion system, the small projecting bristles or hairs could be clearly seen not only at the border of the cells, but on their surface.

From the abundance of blood-vessels, and the infiltration of the tissue around them with lymphoid bodies, the following inference concerning the mode of development of the growth may be made: the lymphoid bodies were white blood corpuscles having transuded through the walls of the capillary blood-vessels; they, being movable, infiltrated the surrounding connective tissue, and developed in the mucous layer into epithelial cells.

ON THE MEASUREMENT OF THE PROMINENCE OF THE EYE.

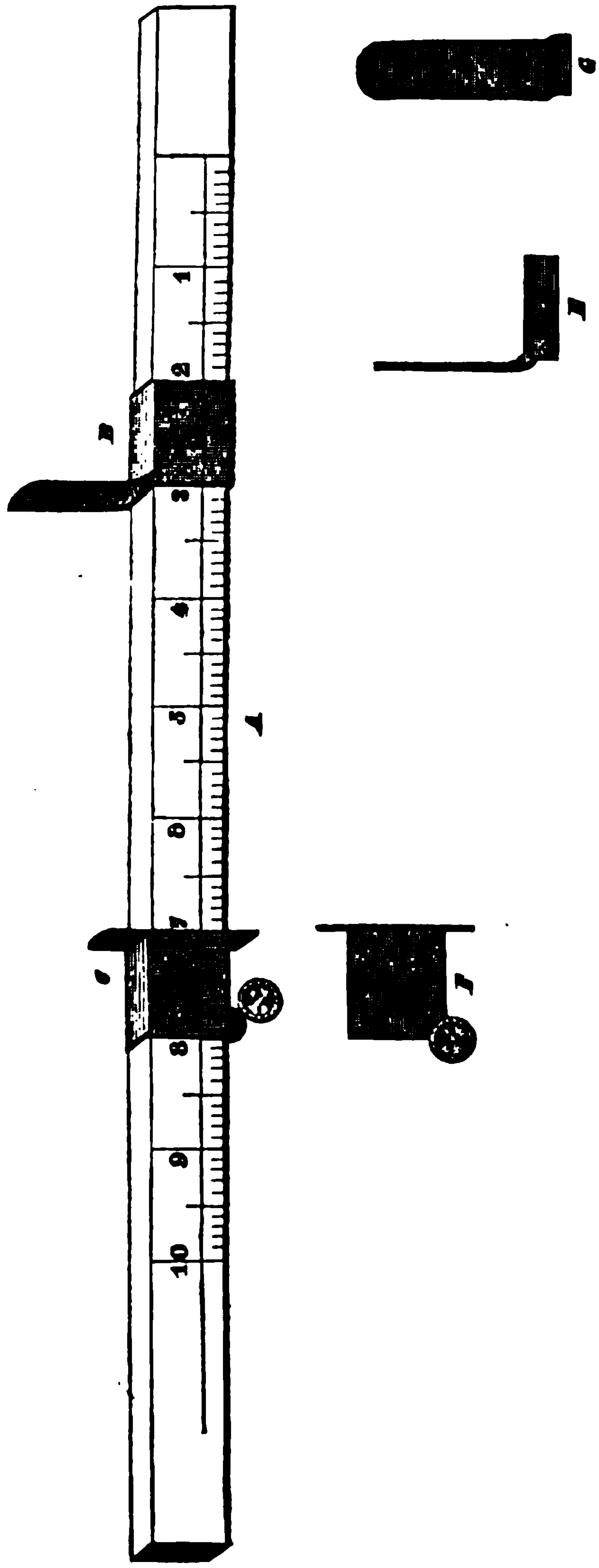
By P. KEYSER, M.D.,

Surgeon to the Philadelphia Eye and Ear Infirmary.

Some years ago, being desirous of measuring the prominence of the eyes in a case of Graves' disease, and knowing that the edge of the outer wall of the orbital foramen is never covered with anything more than thin integument at all times, by lean or fat persons, I thought this quite a good point to measure from, and had a little instrument made for that purpose, which has been very serviceable to me ever since.

It is made of ivory (or of metal), 15 centimetres long, 6 mm. wide, and 3 mm. thick—Fig. 9, "A." It is ruled with the centimetre and millimetre scales. On one end is a silver slide, with a projecting part for fixation against the orbital edge of the malar bone, see "B" and "E;" this slide works on a stiff spring, set in to hold it firm in place, but still allows it to be moved when required. On the other end is another slide, working on a very light spring and easily movable, having a ratchet

and thumb-screw to regulate its movements, and has projecting from it two uprights of thin steel. See "C," "D," and "F."



I move the slide *B* on the rule, to give me a good long, firm rest against the side of the face between the ear and eye, placing the projecting part of the slide *B* well against the orbital edge of the bone, and hold it firmly with one hand, while with the other the slide *C* is brought up and regulated so that the little upright stands exactly on a line with the outer surface of the cornea, the patient being directed to look steady at a fixed point directly in front. The distance between the two slides gives the prominence of the ball from the skin, and from the bone add 2 mm. At the same time the exact measure of the cornea can be taken by marking the sclero-corneal line.

The slide *C* having an upright on either end makes it suitable for either eye.

After measuring many hundreds of eyes with this Exophthalmometer, I find the prominence to be in a healthy normal state from 9 to 18 mm. In many cases of myopia I have found no material change, while in others great extension was perceived.

In one case of a myopia of $\frac{1}{3}$, the R. E. showed a prominence of 19 mm. and the L. 20 mm.

In a few cases of Morbus Basedowi (Graves' D.) that I have seen, the prominence was from 20 to 22 mm., and in one very marked case of exophthalmus, which came on gradually in about three years, without any sickness or symptoms of Graves's disease, the prominence reached 24 mm.

I found the average prominence in health, at and above maturity, to be 14 mm.

It was seldom that there was any material difference in the eyes; the greatest amount I found was 2 mm. In very many persons, if not a great majority of the people, the two sides of the face are not equal, one being more prominent than the other, so that one eye appears more projecting; but as we desire to have the prominence of the ball beyond the orbital foramen, it matters not if the outer edges are not exactly equal and on the same line; this is governed by the whole contour of the face.

Since reading Dr. *H. Kohn's* (of Breslau) able article in the Klinische Monatsblätter, V. Jahrg., p. 339, with whose exophthalmometer I am much pleased, I have examined

and measured a great many skulls, and find that the supra-orbital arch is often as irregular as the outer malar edge; and the integument is so irregular in one and the same person, that I really think the outer edge from which I measure is about as correct as any point found yet. In no one skull did I find the mastoid processes on the same line or of the same shape, so that from them I could not get even and exact centre lines for points to measure from. But on measuring from the tubercles on the temporal bones, or a line drawn through the centre of the glenoid fossa on either side, I found the measurement of the two sides pretty nearly if not exactly alike.

A NEW FORM OF WIRE SNARE FOR THE REMOVAL OF AURAL POLYPI, MODIFIED FROM THAT OF WILDE.

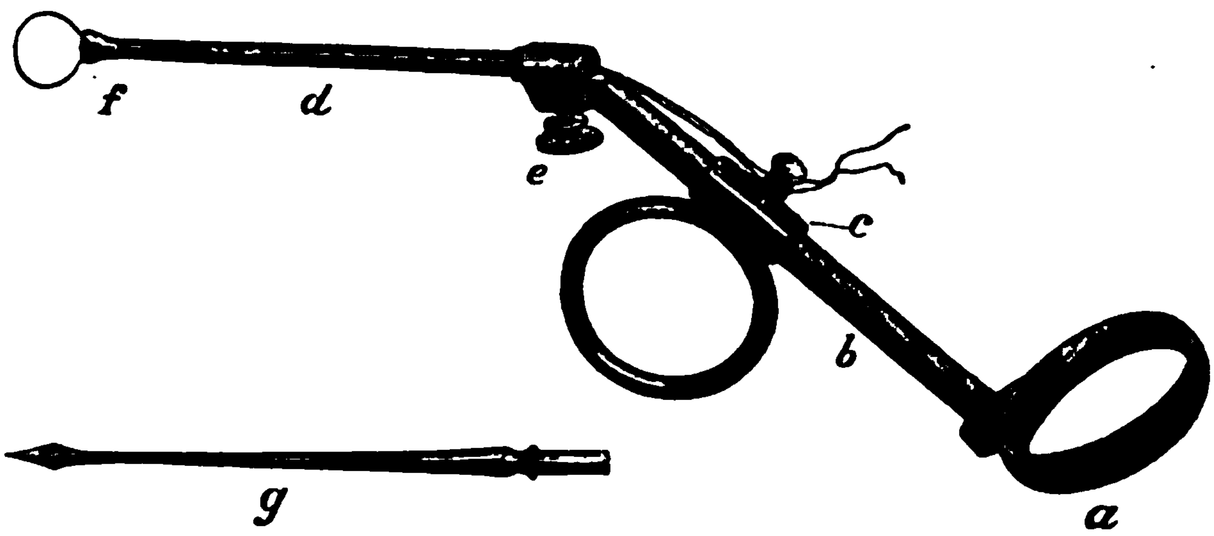
By C. J. BLAKE, M.D., Boston, U.S.A.

Among the instruments employed for the removal of aural polypi, the wire snare designed and introduced by Sir Wm. Wilde is the one in most general use. Modifications made by different operators are numerous, but in all the general form has remained the same.

While operating with a Wilde's snare upon a polyp deeply seated upon the anterior wall of the meatus, I conceived the idea of an instrument which should obviate the necessity of turning the hand, and with it the whole instrument, to enable the wire loop to be slipped over a growth springing from the sides of the meatus or the cavity of the tympanum, and ordered one made for me by Leiter of Vienna.

This I operated with several times, and modified successively until it reached its present form, constituting in point of fact two instruments, a snare and a myringotome. (See figure.)

The tube, slide, and thumb-ring are made of German silver (Pakfong), the remainder of the instrument of steel.



The thumb-ring (a) screws on to the lower end of the handle (b), and can be easily removed, or, by slightly unscrewing it, can be turned to the right or left to suit the convenience of the operator. On the handle (b) runs the slide (c), furnished below with a ring for the middle or index-finger, and above with a pin for the attachment of the ends of the wire.

The upper end of the handle enlarges to form a band into which the tube (d) is inserted, and fixed in position by the small set-screw (e).

As is shown in the engraving, the tube widens at its extremity to form a flattened head (f), having two small openings in its face for the passage of the wire. These openings unite below the head to form a common canal.

By unscrewing the thumb-ring (a), allowing the slide (c) to slip off, and substituting for the tube (d) the lance-headed needle (g), we have an instrument which

has the advantage over the one in general use, that the broad lance-head may be given any desired direction, being kept in place by the set-screw (e). Other instruments may be substituted for the needle.

When the growth to be extracted arises from any part of the meatus other than the superior or inferior wall, that is to say, directly in the median line, it is necessary, with Wilde's snare, either to turn the instrument sideways, which is at least inconvenient, or to twist the wire upon itself, in order to bring the flat of the loop in contact with the base from which the polyp springs.

In the latter case, when traction is made, the wire tends to return to its original position and the growth is apt to be obliquely excised, in place of being cut off close to its base.

In substituting for the fixed bar of Wilde's snare a movable tube, this difficulty is obviated.

The broad head, and with it the wire loop, can be given any desired direction, and the instrument introduced without changing the position of the hand.

In operating I have found a ring upon the slide more convenient than two arms, and by fastening the ends of the wire to a pin above the slide they are out of the way of the operator.

When greater steadiness is desired, the index finger may be rested upon the small set-screw and traction made with the middle finger.

In a narrow meatus it is also an advantage to have

the wires enclosed within a tube, in place of running upon the outside of a bar.

In setting the instrument the wire should be passed through the two holes in the head and down the tube, the two ends being twisted around the pin in opposite directions; the head of the tube is made to flare outwards gradually, and the liability of the wire to break thereby diminished.

Of the different kinds employed, I have found the Lyons wire suggested by Prof. Moos to best answer the purpose; it is soft, and yet sufficiently stiff to bear considerable pressure.

The size No. 12 (silvered), used for sewing leather, is perhaps the most convenient, and has an advantage over the annealed iron wire in being smoother and less likely to break with continued use.

In employing the needle for the purpose of perforating the membrana tympani, the plane of the lance-head being turned in the direction in which the incision is to be made, and the needle then screwed tightly in position, a direct puncture may be made without moving the hand to right or left, and greater steadiness in operating thereby secured.

REPORT OF A CASE OF DETACHMENT OF THE CHOROID FROM THE SCLEROTIC AFTER AN OPERATION FOR CATARACT, WITH PARTIAL LOSS OF VITREOUS BODY.

By GEO. REULING, M.D.,

Surgeon to the Maryland Eye Infirmary, Baltimore.

THE fact of the occasional separation of the choroid membrane from the sclerotic has been demonstrated by the ophthalmoscope and by dissection.

V. Gräfe had already, in 1854, diagnosed, by the aid of the ophthalmoscope, a similar case, and has described (Archiv für Ophth., Bd. IV., Abth. 2) two other cases which he observed in 1855 and 1857. These three cases had, as a common feature, separation of the retina superadded to and consequent upon the choroid displacement, with total atrophy of the ball. His opinion as to the physical cause of the lesion could be only approximatively given in the absence of opportunity for dissections. The result to which he however arrived was, that the lesion had its origin in effusion, either serous or sanguineous. The fact of the existence in one case of effused blood at the dependent portion of the periphery of the prominent de-

tached choroid seemed, however, to Gräfe to favor the view of an apoplectic origin, while in others the subsequent separation of the retina by serosity, and the consequent atrophy of the globe, suggested that the whole process might be attributed to that serous effusion which had been so prominent in the later phenomena. *Liebreich* has also (Traité pratique des maladies de l'œuil par Mackenzie : Section : Décollement de la Rétine et de la Choroïde d'avec la Sclérotique), as well as in Archiv für Ophth., Bd. V., Abth. 2, described similar cases, and enriched our knowledge by many interesting observations, and also by a very valuable drawing of the ophthalmoscopic appearances in a case of detachment of the choroid (Tab. vii., fig. 4 of his Atlas). The rarity of this affection readily accounts for the small number of pathologico-anatomical researches. We find, however, one recorded by *Ammon* (Zeitschrift für Ophthalmologie, Bd. II., p. 24) and three by *Stellwag* (Ophth., 1856, Bd. II., p. 98, par. 142, Anmerk. 109). The greatest interest attaches to cases very fully reported with valuable details by *Iwanoff* in "*Archiv für Ophth.*," Bd. XI., Abth. 1, and also by Prof. *Knapp* in his work upon *Intraocular Tumors*.

The latter author describes, page 194 (261 Am. edit.), a very interesting, and at the same time instructive case, in which, about seven weeks after the extraction of the opaque lens, the whole of the corpus ciliare and the attached choroid were found separated from the sclerotic in the enucleated eye. Prior to enucleation, *Knapp* had already, by the aid of the ophthalmoscope, recognized a

prominence, of hemispherical shape, which he took for an encysted coagulum of blood rather than for melanotic sarcoma, to which it bore a great resemblance. In this case (vide Fig. 69, op. citat.) the sclerotic was much thinner than normal in the ciliary region, and considerably thickened at the equator, so that *Knapp* attributed the serous separation of the parts to a plastic sclerotitis, due to the forcible extraction of the lens, which caused at once the thickening of the sclerotic, and the effusion of serum between this membrane and the corpus ciliare, and thus gave rise to bellying of the choroid. In an article by my friend Dr. *de Gouvea*, which appeared in *Gräfe's Archiv* (Bd. XV., Abth. 1.), are related two cases of separation of the choroid, both of which (Cases II. and III.) were attributed to a considerable puffiness (Auflockerung) of the lamina fusca, due to structureless exudation.

Choroid detachments due to hemorrhage from the posterior surface of the retina, after operation for cataract, together with the anatomical appearances, have been described by Mr. *Hulke*, and after him by *Bowman*, *White Cooper*, *Lawson*, and others. Such hemorrhage occurs only in eyes previously diseased, and my own experience offers a very striking case in which, immediately after an otherwise normal operation for the extraction of both lenses of an old lady, the subject of arterial atheroma, a severe attack of pain was accompanied by the protrusion in both eyes of the vitreous body through the wound in the cornea, followed by

swollen and cyst-like retina and choroid. At the same time there was a very severe hemorrhage from the choroidal vessels, which could only be restrained by styptics and compressing bandages. Of course both eyes were totally destroyed by the ensuing suppuration.

I shall now relate the case to which the title of this communication refers.

In the spring of 1867, a peasant woman, aged 45, the subject of double uncomplicated cataract, was admitted for operation into the Eye Hospital at Wiesbaden.

State on Admission.—Right Eye: Only motions of the hand perceptible, with perfectly responsive pupil, and undiminished field of vision.

Left Eye: Fingers at eight feet. The patient was an anæmic and easily excitable subject, belonging to the laboring class, and was operated upon while under chloroform by Dr. Pagenstecher. Lower flap operation and large iridectomy, with attempt to slip out the lens by rocking motion (Schlittenmanöver), which being unsuccessful, Pagenstecher introduced his own scoop between the posterior surface of the lens and the fossa hyaloidea, and by the aid of slight pressure upwards, and careful traction, succeeded in separating the lens from its connection with the zonula, and accomplished its extraction with the unbroken capsule. A small quantity of vitreous body, to the extent of about 15 drops, and of normal appearance, escaped through the wound, immediately following the lens. The cornea collapsed to a moderate degree, and there was a slight trace of hemorrhage in the anterior chamber. The corpus vitreum had, with the exception of a small particle caught in the wound, entirely regained its normal position.

Solution of atropia was now instilled and the eyes bandaged.

1st day. The first 24 hours were passed favorably. The patient had vomited somewhat on two occasions on awakening from the narcosis. This, however, did not prevent the prompt and entire closure of the wound. Cornea smooth and convex, aqueous humor almost perfectly

clear, only a slight streak of blood on the face of the iris. The patient counts fingers at 4 feet.

2d day. Patient very comfortable, and all well.

3d day. Patient complains of great feeling of fatigue, depression, and chilliness. No complaint as to the eye. Fingers counted at 6 feet. Temperature and pulse rate markedly increased towards evening, and slight delirium appeared. The remission in the morning was accompanied by a diminution of temperature amounting to 1°. Two days subsequently a notable increase in the area of splenic dulness could be perceived, profuse painless diarrhœa appeared, and in the night of the 6th day the delirium became furious, so that the patient tore off the bandages, and thus gave rise to a gaping of the wound and hemorrhage into the anterior chamber. The bandages were immediately replaced, and the patient, uncontrollable in her delirium, was sent to the city general hospital, where, after three weeks, she gradually sank into excessive weakness and death. The post-mortem examination yielded comparatively slight changes in the mucous membrane of the ileum, consisting principally of ulcers in the process of healing, and a corrugated appearance of the capsule of the spleen, due to the contraction of the previously swollen organ. The brain and optic tracts showed no perceptible lesion. The eye was now enucleated, and immersed for the space of two weeks in Müller's fluid. It was then carefully divided in the horizontal diameter into two equal sections. This yielded the interesting discovery of the total separation of the choroid from the sclerotic, between which two membranes a jelly-like exudation to the extent of 0.5‴ in thickness was spread. It had been unquestionably in a fluid state prior to the hardening in Müller's fluid. The separation extended from the circumference of the optic disc to the ciliary ligament, and was complete, so that the exudation removed the choroid from the sclerotic over its whole extent to an almost equal degree. The arteriæ ciliares posticæ breves, and the ciliary muscle near the canal of Schlemm, constituted the only connection between sclerotic and choroid. No detachment of the retina was anywhere perceptible; choroid and retina were in perfect apposition and showed no trace of wrinkle. The corpus vi-

treum was perfectly normal, and a microscopical examination of the structure discovered no change. The gelatinous exudation was perfectly clear, with the exception of a few points of slight opacity. Under the microscope there was no trace of structure visible, only here and there were a few granular fibrils and particles of coagulated fibrin, to which were attached a few pigment grains and cells of the lamina fusca.

This case suggests diverse reflections. The cause of the choroid detachment is simply to be sought for in the vacuum produced by the removal of the lens and the escape of part of the vitreous body. It is not probable that the accident happened at the time when the patient violently removed the bandages, and thus opened the wound and occasioned the hemorrhage; for on this occasion there was no loss of vitreous body. The loss of aqueous humor could have been but light, since the anterior chamber was perfect as I replaced the bandages. It is thus rendered exceedingly probable that the total detachment of the choroid does not involve total loss of sight so long as a connection between this membrane and the retina is unbroken, or, at least, that it does not lead to this result in the earlier stages of the lesion—for it will be remembered that three days after the operation the patient could count fingers at six feet distance. The art. cil. post. brev., in the circumference of the optic disc, were, as before mentioned, not ruptured (the exudation between sclerotic and choroid was not blood-stained), and therefore there was an uninterrupted blood supply from this source as well as from the branches of the art. cil. long. et ant., which course

backwards from the ciliary body, and, anastomosing with the terminal branches of the art. cil. breves, form a delicate network which extends to the ora serrata, and is closely continuous in the neighborhood of the entrance of the optic nerve with the capillary vessels of this nerve (*Leber*). There is no doubt that a longer duration of the affection under consideration would lead, through disturbed nutrition and gradual separation of the retina, to total blindness; and it is to be regretted that after the manifestation of phenomena of excitement in our patient, no test of vision could be had, and that the bleeding into the anterior chamber prevented all attempts at ophthalmoscopic examination.

THE USE OF ACETIC ACID IN AFFECTIONS OF THE CONJUNCTIVA AND CORNEA.

BY B. A. POPE.

THE acid used in the following experiments was uniformly of the specific gravity of 1,041 (No. 8). My experience in its use in other strengths is not sufficiently extended for the expression of an opinion upon its value.

At first I applied the acid by means of a soft piece of wood, sharpened to a very fine point; but subsequently substituted the smallest size camel's-hair brush. In making the application, great care should be taken that the brush should not hold too much of the acid, and it is well also to remove any moisture from the surface to which it is to be applied.

Its action in the strength indicated is that of a mild escharotic, when applied to the cornea or the conjunctiva, causing but moderate reaction and very transitory pain. As compared with the nitrate of silver, used in strong solutions or in the solid state, the pain and irritation produced are very slight. This is also true as regards its

action when compared with that of the sulphate of copper. The epithelial slough falls away rapidly, and leaves a clean surface, which, as a rule, heals promptly.

In the following cases I found this acid to be a valuable agent:—

1. In a case of *warty degeneration* of the palpebral conjunctiva.

The patient, a boy of twelve years old, had been treated for two years before coming under my care. The tarsal conjunctiva of the upper eyelids was almost entirely occupied by these growths, only the inner and outer portions of the lids having been free from them. They were packed closely together, and were flattened upon their surfaces where they came in contact with the eyeballs. The largest of the tumors was about one-sixth of an inch in length, firm in structure, and sprang from the middle of the lids. Here and there, towards the inner and outer canthi, there were small flat growths varying from the size of a small pin's head to a line in diameter. There was only moderate conjunctival irritation, and but little secretion of mucus. The corneæ were perfectly healthy, but the use of the eyes was unpleasant.

The growths were excised as closely as possible to the surface of the lids. They, however, so completely occupied the tarsal surfaces of the lids, that it was impossible to make the excision so as to leave a smooth surface. The tendency to reproduction was very great, and it was found necessary to cauterize the diseased surfaces with

the solid nitrate of silver every day for at least two months. At the end of that time the right lid was well. The treatment for the left lid was terminated at the end of five months. During the latter part of the treatment the sulphate of copper was sometimes used. After the first two months the nitrate of silver was generally applied every second or third day.

After three months the patient again returned for treatment, the left lid being almost in the same condition as before I had commenced treatment; and the disease also commencing to show itself again on the right lid. I now determined to try the effects of acetic acid, without previously excising the growths.

The applications were made once a day for about six weeks. In a week from the commencement of this treatment the right lid was well. In from six weeks to two months the left lid was also well. During the last week of the treatment the solid nitrate of silver was used two or three times with benefit.

The pain was very moderate, and the irritation following the applications was very slight. As compared with the applications of the nitrate of silver, or even of the sulphate of copper, the difference in these respects was very great. The patient consequently expressed himself as being much in favor of the change in treatment.

In the latter part of the treatment the whole thickness of the epithelial layer would slough in places, and this would be followed by a little hemorrhage and some increase in the amount of pain.

It is now about five months since the cure was effected, and there is no tendency at present on the part of the disease to return.

There are in such cases serious objections to excising the growths, and following this by the use of strong caustics. This treatment almost certainly produces an uneven surface, which causes chronic irritation, by the unequal pressure of the surface of the eyelids upon the balls. If strong caustics be used for a long time upon the growths, the violent irritation produced is liable to be prejudicial to the healthy conjunctiva and cornea. Acetic acid seems to answer the indications best, since its action appears to be in a great degree confined to the immediate points to which it is applied. In case the growths are isolated and large, and attached by a small base, excision is of course indicated. In this case the deeper tissues of the lid were beginning to be involved in the morbid process, and the tumors were closely packed together.

Each application of the acid caused the destruction of the epithelial layer, in which the morbid process seemed to originate. As a rule it did not slough at once, but upon the return of the patient in 24 hours the epithelium had been reproduced. The acid was always applied very freely.

2. In the greatly relaxed condition of the conjunctiva of the cul-de-sacs with hypertrophy of the epithelial layer which occasionally follows upon chronic conjunctival disease. I have frequently found this condition of

the conjunctivæ in cases of chronic catarrhal affections occurring in orphan asylums, and in some instances they were very rebellious to the usual treatment. This condition renders the patient constantly liable to relapses. One case of this kind, in which a constant irritation was kept up by the condition of the conjunctiva of the upper conjunctival cul-de-sacs, was cured completely by two applications, after having resisted the usual treatment for weeks without decided progress towards a cure. In this case, upon everting the upper lids, a large flabby mass would protrude which had a macerated appearance.

3. I have found benefit in its *occasional* use in some cases of trachoma in the stage of development, where the neoplastic growths were *very superficial*, and where the usual treatment seemed for the moment to favor the progress of the disease. Its application should be confined to the granulations, the surrounding conjunctiva being spared.

4. In a case of inflamed pinguecula, where excision was declined by the patient.

5. In the hypertrophied condition of the lachrymal caruncle and semilunar fold in cases of pterygium. It is probably best to use it before operating the morbid growth, since the cure is favored by having the tumors free from irritation before operation.

6. In two cases of *calcareous degeneration* of the *epithelial* layer of the *cornea*.

In each of these cases both eyes were affected, and in both the disease was more advanced in one eye than in

the other. The treatment was completed in only one of the cases. In this case the result was excellent in one of the eyes, and very unsatisfactory in the other. The eye which did well was by far the worst, the patient not being able before treatment to read the large letters of signs upon the streets, and the eye having become affected with strabismus externus. The eye which was a failure in respect to the operation did quite well after two or three operations in which the acid was used, and improved decidedly in the sight; but the last operation was followed by considerable irritation of the cornea and acute inflammation of the lachrymal sac. This last operation was performed with instruments, and without the use of the acid; so that the failure can in no way be connected with its use. In the cases reported by Bowman and Dixon the disease had advanced so far that the calcareous mass could be removed in a continuous solid plate. In the cases treated by myself the disease was in a comparatively early stage of development, and might easily have been mistaken for opacities resulting from a diffuse superficial keratitis. In fact, both cases had been so considered previously to their having consulted me, and had been treated accordingly, without any effect upon the course of the disease. From two of the corneæ I obtained small, coarsely granular, calcareous plates; but the epithelial layers were mostly in a sclerosed condition, the cells still retaining their forms and proper relations when seen under the microscope.

The treatment was commenced by the application of the

acid at the circumference of the diseased parts. After an hour or two the sloughing mass was removed, and if the whole thickness of the diseased epithelium had not been destroyed, the application was renewed at once, with, however, greater care than in the first application. Before another application was made, time was allowed for the restoration of the epithelium and the subsidence of irritation. In some of the operations I first scraped away much of the epithelium, and then made a slight application of the acid to the remaining deep epithelial layers.

The restoration of the epithelium took place very rapidly, and with so nearly normal transparency that in the eye on which the treatment was successful, the patient could read No. 1 of Jaeger's test-print at 7″ or 8″, while before the operation, with this eye, which was much the worse of the two, the patient could not distinguish the letters of large street signs, and the eye had in consequence deviated outwards.

From the observation of the effects of treatment in these cases, I concluded that unless some other procedure than that with the knife, or by sloughing away the epithelial layer, be resorted to, the disease had best be allowed to run its course to a rather advanced stage before operative intervention.

7. In a case of dense opacity of the cornea, the margin of which reached the centre of the cornea. This case I treated from the eighth day of an attack of ophthalmia neonatorum, complicated almost from the first by a severe attack of diphtheritis conjunctivæ. I first saw

the case on the eleventh day after the birth of the child. There had been no treatment, and I found the cornea commencing to slough, and severe iritis already existing. The eye was saved with difficulty, and perforation of the cornea was prevented. A circular slough came away, about 1¼ line in diameter, and probably involving ⅓ or perhaps a little more of the thickness of the cornea. The healing of the ulcer and the condensation of the cicatrix was slow, on account of the unfavorable external and internal conditions present. At intervals, for some months, the various treatments usual in such cases for diminishing corneal opacities were used, but with unsatisfactory results. After some months had elapsed without treatment, I commenced the use of acetic acid. Its application was confined to the dense opacity, and its immediate vicinity, where the opacity was very slight. At first the application was made once a day for three consecutive days, so that an ulcer resulted from the treatment. This was allowed to heal without interference. This treatment was repeated after the ulcer had healed and all irritation had ceased. The application of the acid was made subsequently about three times, but each time only two applications were made. The opacity still remains, but is decidedly diminished in density, and somewhat also in extent. The healing of the ulcer took place under the most favorable conditions, which will probably sufficiently explain the improvement. In support of this view I might cite the case of a child, about three years old, who had a tolerably dense central opacity of the

cornea, which sloughed away under the influence of a severe catarrhal inflammation of the conjunctiva. The inflammation produced iritis and considerable softening of the corneal tissue. After the cure of these inflammations the ulcer healed, with a remarkable improvement in the opacity. The first cicatrization had taken place while the conjunctiva was still inflamed, the disease having been left mostly to take its natural course.

ANÆSTHESIA OF THE CORNEA, AND CONCURRENT DIMINUTION OF THE ACTION OF ATROPIA ON THE IRIS, AS INFLUENCING KERATIC ULCERATION.

By I. S. HILDRETH, M.D.,

Clinical Lecturer on the Eye and Ear at the County Hospital, Chicago.

From a series of observations upon this subject, the following case, reported by Dr. B. C. Miller, House-Surgeon, is selected as one of the most important.

Catharine Olston, Swede, age fifty-two, was admitted to the medical department of the hospital, April 18th, 1868. She had been suffering, for three months, from chronic diarrhœa, caused by exposure and bad diet. Her limbs were wasted, the countenance was haggard, and the skin shrivelled. On the 25th she first complained of her eyes. Examination discovered, near the lower margin of each cornea, an external ulceration, occupying quite one-third of its thickness, laterally elongated, and about one-sixteenth of an inch in vertical breadth. The pupils, a little contracted, slightly responded to the influence of light and shade. The corneæ were almost

totally insensible to touch. The passage of the point of a small strip of paper, torn from the margin of a magazine, twisted hard until like a sharpened lead pencil, the apex then slightly moistened, being scarcely felt, even when rudely drawn across them.

In neither eye was there intraocular tension, posterior synechia, discoloration of the iris, or perikeratic injection; and the corneæ, except at points of ulceration, were quite clear. Slight catarrhal conjunctivitis was present. General condition very weak.

Two or three drops of atropia solution* were instilled within the lids of each eye three times during the next eighteen hours. No other local treatment. April 26th.—The pupil of the right eye was slightly dilated, and the cornea had become somewhat sensitive to touch. Its ulceration had not increased. The pupil of the left eye remained contracted, and the cornea as insensible as before. Its ulceration had enlarged. General condition still declining.

27th.—Atropia had been applied, since last record, to each eye, three times. The pupil of the right was further dilated; the cornea more sensitive, and its ulceration showed signs of improvement. On the left, the pupil was still contracted, corneal insensibility remained, and its ulceration was increasing. General status worse.

28th.—Atropia had been further instilled twice as before. Right pupil well dilated, and the cornea quite

* Ten grains to the ounce.

sensitive. Its ulceration diminishing. Left pupil remained contracted; the cornea insensible, and its ulceration was further enlarged. General state of patient continued to fail.

29th.—Atropia had been instilled once in right eye; twice in left.

In the first the pupil was largely dilated, the cornea quite sensitive to touch, and its ulceration had still further diminished.

In the other the pupil remained contracted, and the cornea full as insensible to touch as at time of first examination. Its ulceration had extended from the point of commencement, at the lower margin, nearly to the centre of the pupil, thereby involving about one-half of the cornea.

The patient died, from inanition, during the following night. Careful watch could at no time discover any constitutional effects of belladonna.

The general treatment consisted of stimulating and sedative remedies, with a small portion of opium, and an appropriate supporting diet.

The above brief presents a patient emaciated, feeble, and shrivelled by one of the most depressing diseases.

No synechia, change of color, perikeratic injection, intraocular tension, or other apparent evidence of disease of the internal membranes existed. The corneæ were anæsthetized, yet clear, except at points of ulceration; and the pupils, though their dilatability was quite defective, were still perceptibly influenced by light and

shade. No local treatment besides atropia at any time was used. The right eye being susceptible to its influence, the pupil gradually dilated, and a concurrent removal of corneal anæsthesia followed, with, first, arrest of ulceration, and, then, reparative efforts.

The other eye being insusceptible to the remedy, the pupil refused to dilate, corneal anæsthesia persisted, and the ulceration steadily enlarged.

Notwithstanding the ophthalmic affection, when first observed, was quite equal in each organ, and of a nature —corneal ulceration—but too easily attributable to the *general* defective nutrition, yet that cannot be assigned as the principal cause. For such a conclusion must be untenable when local medication influencing one eye is followed by arrest, and even some repair, of the keratic disturbance, while the same treatment, finding insusceptibility to its influence, in the other eye is followed by continuance of the destructive process. The cause, therefore, was some *local defect* of nervous action, which belladonna was competent to relieve on the one side, while it failed on the other.

CONTRIBUTIONS TO PHYSIOLOGICAL OPTICS.

By B. A. POPE, M.D.*

1. *The effect of pressure upon the eye in the experiments for observing the entoptic currents and luminous bands.*

While making experiments for observing the entoptic currents, I remarked that they would at times appear sooner and more distinctly when my eyes were strained by looking as far upwards as possible. Intermittent pressure upon the eye with the eyelids has the same effect. Also, at times, when my eyes were turned away from the *strong* light, and the eyelids were closed, moderate pressure on the eylids with the fingers would cause a reappearance of the currents. These facts caused me to study more closely the effect of pressure, exerted by means of the finger, during the experiments. When at times, upon commencing the experiments, the currents do not appear, they immediately do so when a certain

* This is the continuation of the article entitled "Entoptic Phenomena connected with the Circulation of the Blood," which appeared in Vol. 1, No. 1, of these Archives. This portion reached the editors too late for publication in the same No.

amount of pressure upon the ball is exerted with the finger. When my eyes have been fatigued by observing the currents, and these in consequence become obscure or entirely disappear, pressure upon the eyeball will cause them at once to appear more distinctly or to reappear. When I observe the currents and the luminous bands simultaneously, and exert pressure upon the eyeball, the luminous bands disappear upon *moderate* pressure, while the currents become more distinct. The pressure has to reach the point at which the function of the retina is almost suspended before the currents entirely disappear. Intermittent pressure often increases the distinctness with which the luminous bands are seen, and with this is combined a greater distinctness in their pulsatory movement. There are two modes in which the difference in the degree of pressure required to cause the disappearance of the luminous bands and the currents might be explained, according as the cause of the entoptic currents is supposed to be located in the retina or the chorio-capillaris.

a. If both phenomena are caused by the circulation of the blood in the retinal capillaries, then we may assume that the luminous bands are caused by the circulation in the finest capillaries, which are liable under normal conditions to obstruction, and consequently to collapse; while the currents can be supposed to be caused by the circulation in capillaries large enough to require abnormal tension of the eyeball to cause their collapse.

b. If it be assumed that the currents are caused by the

circulation in the chorio-capillaris, then the greater resistance of the sclerotica and the choroidea to pressure would explain the difficulty in causing the currents to disappear.

2. *The condition of the accommodation, and the relative positions of the visual axes of my eyes during the experiments for observing the entoptic currents and luminous bands.*

In order to determine the state of the accommodation and of the external muscles of the eye, I used a moderately illuminated, slightly roughened white surface; and used as the object of fixation a very fine vertical black line, or a small black dot.

It was thus only necessary to suddenly uncover the eye not used in order to detect the presence or absence of double images of the point or line; while the greater or less distinctness of the objects would determine with sufficient accuracy the state of the accommodation.

In this manner I determined that ordinarily, when the currents are most *clearly* and *easily* seen, either the eye used was accommodated for the distance of the luminous surface, and the axes of vision intersected at a different (nearer) point, or that the axes of vision crossing at the object observed, the eye was accommodated for a farther point; or, again, that neither the point of intersection of the axes of vision, nor the point for which the eye was accommodated, coincided with the point observed nor with each other.

3. *A new method of observing entoptically some of the larger retinal blood-vessels.*

If I look upon a bright sky, and at the same time press upon my eye with considerable force, an obscure, tremulous, pulsatory movement is observed. If the pressure be now increased, an entoptic figure of some of the larger retinal vessels is seen. The figure only remains momentarily visible, appearing first at the upper and lower margins of the optic papilla, as do the vessels seen entoptically by other methods. The figure presents the same brilliant white appearance as do the luminous bands. The appearance of the figure coincides in time with the pulse at the wrist. Upon repeating the experiment till my eye is fatigued and irritable, an indistinct pulsation and shadowy figure continues to appear for some time after the pressure upon the eye has ceased. If I then observed this in connection with the luminous bands, I found that their pulsatory movement was very decided, and coincided in time with the appearance of this figure, and with the pulse at the wrist. The short time that the figure remains visible renders a minute study difficult; but I am quite sure that only one set of vessels, either veins or arteries, are *directly* concerned. It is highly probable that changes occurring in the veins are the cause of this phenomenon. There are only two conceivable explanations of this appearance, viz.: either we must suppose that it is caused by the collapse of the veins, taking place with and caused by each pulsation of the central artery of the retina, or we must assume that it is a phenomenon in the nature of a phosphene, caused by the suddenly increased pressure of the column of blood in the arteries

along their course. If, as seems to be most probable, a collapse of the veins is the cause, it is easily explicable on the ground that by the sudden emptying of the veins, portions of the retina are exposed to a strong light, to which they are not habituated.

RECOVERY OF COMPLETE NERVOUS DEAFNESS.

By S. MOOS, M.D.

Translated by Dr. Joseph Aub, of Cincinnati.

Severe intracranial disease after acute rheumatism of the joints.—Peculiar nervous phenomena, combined with complete deafness for noises, musical tones, and speech.—Necessity of communicating with the patient in writing for several weeks.—Complete recovery.—A rare experience in favor of employing the constant current.

On the 10th of April, 1869, my friend and colleague Dr. Picot, of Carlsruhe, invited me to see a patient there, who had completely lost her hearing after a long and severe illness. I accepted this invitation on the 16th of the same month. *The following is the history of the case, as related by Dr. Picot:—*

Miss S. D., æt. 19, born of healthy parents, and who had never before been sick, took a severe cold on Feb. 9th, 1869, the result of a draught of air on a body overheated from dancing, and was confined to bed already on the following day. She had slight chills and shooting pains which spread all over the body, especially in the back; every movement was exceedingly painful, appetite disappeared, very great thirst, bowels

costive. The urine could not be voided from the 11th of Feb., but had to be drawn off with the catheter. After these symptoms had continued until the 15th of Feb., considerable swelling of all the joints of the right upper and lower extremities showed itself, combined with continued fever and great pain, making the diagnosis of acute rheumatism a certainty.

During four weeks the disease took its usual course; the fever was always moderate, temperature never rose above 39,5°C. The swelling of the joints in the right upper and lower extremities and in the vertebral joints remained unchanged; occasionally the joints of the left hand and foot were swollen. The pain was always very great (the extremities of the right side had to be laid like fractured limbs for a period of seven weeks). The patient was reposing on a water-bed, and only changed it three times during the seven weeks. During the first three weeks the urine had to be drawn with the catheter. Appetite small. Treatment: Cooling remedies, morph. internally and hypodermically. In the fourth week, with an exacerbation of the fever, a pleuritis on the right side showed itself, and disappeared after eight days.

At this time (in the fifth week), under continued affection of the joints, symptoms appeared which could only be considered as nervous (hysteric). With subsiding fever, better appetite and better digestion, she became gradually ill-humored, showing peculiarities and dislikes; then terrible pains in the right half of the body, excessive hyperæsthesia of the skin, reaching from the sixth rib to the crest of the ilium, and from the vertebræ to the linea alba, set in. The pains occurred periodically, at first 3–4 times a day, afterwards regularly from 12 to 1 o'clock at noon, and in the evening from 10–11, lasting 3–4 hours each time. At first the patient complained of violent burning, and attempted to conceal her pain with great self-command; soon, however, the pain proved stronger than the will of the patient, and she moaned and groaned uninterruptedly. After some time she would have a fainting-fit, lasting from 2–3 minutes, from which state she recovered with slight convulsions, only to continue her complaints. The attacks never ceased abruptly, but the pain gradually decreased, and left an excessive hyper-

æsthesia of that portion of the skin, which would hardly bear the contact of a camel's-hair brush.

For fourteen days all treatment proved futile in shortening the duration of these attacks. Warmth, cold, chloride of elayl, &c., &c., locally used, proved of no lasting benefit; later, in consequence of the great sensibility, it was impossible to use anything locally. During the first days injections of large doses of morphium procured some relief, not by shortening the attacks, but by causing a stupor. Chloroform—of which 120 grammes were given during an attack—only gave relief during the deepest narcosis. Finally, in the 7th week, the attacks became weaker, and disappeared altogether after an eight days' use of large doses of quinine and castoreum. During this period the swelling of the joints, which only remained on the right upper extremity, also gradually decreased; but in their place the following remarkable symptoms appeared in the extremities of the right side: During 7 weeks the nails had stopped growing, a slight excoriation of the skin (dating back to the ball) had not healed; when suddenly the epidermis on the extremities of the right side became detached in large patches, the nails grew with astonishing rapidity, the small lanugo-hair on the arm and leg changed into long black hair, and gave the emaciated hand and arm a peculiar appearance. (After the recovery of the patient the hair on the hand and arm, for cosmetic reasons, was removed by the use of depilatories, and by pulling it out; they did not recur. They still exist on the leg in great profusion, but up to date have not increased in length.)

At the end of the seventh week the patient complained of a terrible pain behind the left ear, on a place about the size of a hand; the left concha was very sensitive, and great hyperæsthesia of the left side of the face existed. *The organ of hearing now was very sensitive, every noise caused pain, the acuteness of hearing was very great.* As a sign of the increased acuteness, we need only mention that the patient understood every word of a conversation which was carried on in a subdued tone in a room on the floor above, and not directly over her bed (deception or fraud not being possible). At this time no anæsthesia was noticed, but immediately following. I must confess, however,

that at the time this acuteness of hearing existed, I did not examine for anæsthesia; when the acuteness subsided, the anæsthesia was very marked. The pains which were designated by the patient as *external*, occurred here as in the lumbar region, in periodical attacks, accompanied by the same symptoms (long continued fainting-fits and slight convulsions), and lasted from 2–3 hours, commencing regularly at 12–1 noon, and 10–11 P.M. The pain gradually decreases, but the hyperæsthesia continues always in such a degree that a hair touching the cheek causes unbearable pains. The attacks, on which morphium and opium had no influence, and which could be borne only in a chloroform-narcosis, disappeared after nine days' use of large doses of quinine. During these nine days the patient lay, without moving, on the right side, *and a considerable ulceration was developed on the right concha. The concha, as well as a spot of the width of two fingers before it, and one as large as a hand behind it, were totally anæsthetic.* The anæsthesia on the right side was complete before, on, and behind the ear. During the height of the disease a diminished sensitiveness for the needle could be proven up to the median line, also in the mucous membrane of the nose. The bladder had to be emptied again with the catheter.

In the eighth week, at length, reconvalescence seemed to set in: the affection of the joints had totally disappeared, no pain of any description existed; sleep, long unknown, was restored, appetite and digestion increased.

The decrease of the sensitiveness of the organ of hearing, however, was accompanied by hardness of hearing, which I was at first inclined to ascribe to the large doses of quinine.

The reconvalescence continued its favorable course, the patient sat up at the beginning of the ninth week, and recovered visibly from day to day. *Yet the hardness of hearing increased in such a degree that at the end of the ninth week she was perfectly deaf, and it was necessary to communicate with her in writing.* The examination of the ears gave a complete negative result, as well as a want of every sensation of

hearing, which was corroborated by my worthy friend Professor *Moos*, whom I called in consultation on the 16th of April.

The galvanic treatment of the ear, which was advised by the professor, had to be dispensed with until a suitable apparatus was procured; more so since the patient could not yet bear transportation.

On the 18th of April, in the 10th week, the patient complained of severe pains in the back, also, that when walking, her limbs nearly refused support, and of inability to urinate. Soon after she also had severe pain in the abdomen, in a region corresponding to the left ovary, in which place, later, a small hard tumor could be felt, deeply situated. The patient lost her appetite, and became very emaciated, without any fever. The pains were continuous, every treatment futile; even the palliative remedies could no longer be used, since morphium and chloroform, which up to this time had been borne very well, now caused severe vomiting.

In the 11th week (29th of April), after the patient had become gradually very moody through her absolute deafness and pains, she had a terrible hystero-epileptic attack; tetanic spasm of the whole body, with complete unconsciousness during 2¼ hours, until the trismus ceased, and clonic convulsions of ½ hour's duration ensued. From this time on she had 2–3 attacks of the same kind daily, lasting 1–1½ hours, preceded by an exacerbation of the pains in the abdomen and the back, loss of consciousness, tetanus, and at last clonic cramps. On the 3d of May she complained for the first time of very severe pain in the brain, on the left side, accompanied by excessive hyperæsthesia of the scalp. The hyperæsthesia of the scalp was decidedly unilateral—left—did not occupy the whole half of the head, the painfulness disappeared gradually towards the median line, was most severe behind the ear and on the back of the head. The skin of the face was in the same condition; the cheek and temple being especially hyperæsthetic, without, however, being ever so painful as the scalp.

All treatment was without success, until, on the 7th of May, I tried the constant current from 12 Meidinger's elements on the despairing patient. The result was a remarkable one. After 8 minutes (the

cathode in the nape of the neck, the anode remaining on the lumbar vertebra, and on a spot of the abdomen corresponding to the ovary) the pains in the back disappeared altogether for the space of ½ hour. The menstruation, which had ceased for ten weeks, returned immediately after the galvanization. The following day I used a constant current of 5 Meidinger's elements, with the anode on the forehead and most painful spot, and the cathode in the nape of the neck, with very favorable results. Pain disappeared for 2 hours, and for the first time in weeks the patient had an hour's refreshing sleep immediately after the galvanization; this day she had only one slight attack. After this she was treated in the same way, with the current on the head and on the neck 2–3 times daily; there was no further attack.

It was never possible to remove the pain from that spot on the abdomen corresponding to the ovary. From the 5th of May the sympathetic nerve of the neck was galvanized daily for 3 minutes with 5 Meidinger's elements. Under galvanic treatment continued until the end of May—the first electric treatment of the ear taking place on the 11th of May—the pains gradually decrease and then disappear; during this time the patient had mimic contortions, lasting 24 hours, on the right side, continuing even during sleep, and also a tetanic cramp of the left forearm and hand, lasting 12 hours. On the 16th of May Profs. *Von Chelius* and *Kussmaul* were called in consultation; *we agreed that we had to deal with an extensive disturbance in the nutrition of the nervous centres.*

We agreed to continue the galvanization of the ear, resp. of the head. From the 17th of May the patient had very severe pains in the stomach, defying every treatment, disturbing the nutrition in a high degree, until the commencement of June, and thereby delaying the reconvalescence. On the 8th of June the patient went to Baden, having no trace of rheumatism of the joints, nor of nervous attacks, with the exception of the still existing anæsthesia of the right ear—(concerning the deafness, see further below.) During the summer she recovered perfectly, and now, the end of September, is as well as ever, all bodily and mental functions being in the best of order.

Although it is not within the scope of this journal to enter into elaborate details of clinical medicine, it has nevertheless been deemed necessary to consider somewhat more closely the clinical diagnosis of the entire disease, in order to form a more conclusive judgment as to what kind of nervous aural affection we had to deal with in the case before us. I believe that if it is at all possible to form an idea how the central organ of the nervous system was affected in our patient, the reader will readily do so after the perusal of the detailed and lucid report of our colleague Picot. Nevertheless it might be of interest to hear the opinion of Prof. *Kussmaul*, who was called in consultation, and kind enough to give me the following in writing, since I was not present on the occasion :—

"It seems to me that we are dealing here with a so-called rheumatic neurosis, extending over large portions of the central and peripheric nervous systems, which, still so little known, have only lately attracted the attention of the profession. I refer to the investigations of French physicians, *Lebert* and others, on the so-called cerebral rheumatism, as well as those of *Griesinger* and others on rheumatic psychoses. At any rate, the diagnosis of acute hysteria is not satisfactory, notwithstanding the many points of resemblance the case before us has with hysteria. This resemblance, however, should not astonish us when we consider that in hysteria as well as in rheumatism of the nerves we have minute changes of the tissues; that in both cases extensive portions can be attacked;

that in both the affection can change from one spot to another; finally, that in the case of our patient, as it seems, an ovary—perhaps its serosa, or the sero-fibrous coat—was affected by inflammatory rheumatism, which may have caused all kinds of reflex symptoms, of a truly hysterical character, and then mingled with those of a purely rheumatic nature. This department of nervous pathology yet awaits proper research, and still wants the first essential, a sufficient number of precise reports of cases."

Results of the examination of the organ of hearing in our patient.—Plan of treatment, and further course of the disease.

On the examination of the ear, on the 16th of April, I found: Anæsthesia of the right concha and external meatus, no reaction of the concha to the touch, nor of the meatus to the different movements and turnings of the speculum during the examination. Nothing abnormal, either in the external meatus or on the membrana tympani; the position and inclination of the membrane, its curvature, color, transparency, light-reflex, and mobility in the act of swallowing (the mouth and nose being closed), &c., were all normal. *On both sides non-conductibility of the bones for the tuning-fork, and for a watch having a hearing distance of thirty feet. We were enabled, however, by means of the double otoscope, to clearly distinguish the vibrations of the tuning-fork when placed on the bones of the head. Deafness for speech was of such a high degree that it was found necessary to communicate with the patient in writing. She is also unable to hear her own words.*

Taking these facts into consideration I felt myself justified in dispensing with the use of the catheter; so much the more so, since my colleague, Mr. Picot, had al-

ready made the manœuvre, thereby convincing himself of the permeability of the middle ear and of the uselessness of the catheter as a therapeutic agent. The patient complained of continued noises in both ears. Since she could not be moved, I recommended that an apparatus for the constant current be procured as soon as possible, and that she be treated systematically with it, expressing the opinion that if benefit was to be derived from any therapeutic agent, it would only be from the constant current of a battery.

Under these circumstances the *prognosis* would have been declared very *grave* by any physician, even if he was not much conversant with ear-diseases; for the aurist this became a duty, since the non-conductibility of the bones, even for such powerful sources of sound as were used for our patient, combined with a total want of abnormality of the middle ear, have to this day been considered as absolutely unfavorable symptoms by all otologists. During the further progress of the disease the prognosis became, if such a thing were within the range of possibility, even still more unfavorable; *for at the second consultation, on the 29th of April, it was found that even the subjective symptoms had totally disappeared, and it could no longer be doubted that there was a perfect paralysis of both auditory nerves.*

We were no longer at a loss as to the plan of the electric treatment. It was necessary to irritate the nerves of hearing as often and as strongly as possible. This was to be accomplished by the daily use of the constant current

with Volta's alternative (one electrode in the hand and the other in the corresponding external meatus, which was to be filled with lukewarm water. I use a vulcanized rubber ear-speculum plugged with cork for the ear-electrode. The metallic wire of the screw which is used for holding the ear-electrode passes through the cork stopper almost to the anterior end of the speculum). In case this treatment should lead to any favorable result, it was determined to continue by treating principally with the anode—the anode being placed in the ear and every reaction with the cathode being avoided.

When, at the end of the first week in May, the technical preliminaries for the application of the constant current had at length been completed, we found, as can be seen from the history of the case, independent complications on the left side. The hyperæsthesia of the left half of the head, which had made its appearance in the mean time, caused such an increased sensitiveness of the concha and external meatus that the patient complained of pain after the most careful introduction or moving of the ear-speculum. This increased on the application of the ear-electrode. We nevertheless insisted on this method of application, and so much the more so, since the other places considered eligible for the application of the second electrode in galvanization of the acusticus were for the most part hyperæsthetic. The electric examinations of both ears, made on the 9th and 10th of May, gave the following result:—

The right ear with 10 Meidinger's elements and 900 resistances of the current of the rheostat placed in the second closure gave on *cathode-closure* a lively whirring sound, which continued for a time during the duration of the cathode and then disappeared; the same result with 10 Meidinger's elements and 800 and 700 resistances of the current; with less resistances no result; further: *

	10 M.E.	900 C.R.	K.O.	—No result.
			An.S.—	"
			An.D.—	"
			An.O.—	"
Left ear:	10 M.E.	400 C.R.	K.S.	—Scratching of a violin.
			K.D.	—The same, lasting a short time.
			K.O.	—None.
			An.S.—	"
			An.D.—	"
			An.O.—	"

The same result with 10 M.E. and 350 and 300 resistances of the current; with 290 resistances, no more reaction.

Notes on the electric treatment of the ear, by Dr. Picot and Dr. Moos.

May 11*th*. *Right*: 10 M.E. KS. jarring, as if you are scratching a slate with a pencil, which continues during KD. In turning to the closing of the anode the sound increases, and becomes almost unbearable during the duration of the anode, leaving after-sounds of half a minute's duration after anode-opening. *Left*: with 6 El. same as right. Sensation = the scratching of a bad violin; during the An.O. after-perception of these sounds for 1½ minutes. Later no more subjective noises.

May 12*th*. Right 4 El. no reaction. 8 El. same reaction as yester-

* For explanations of these abbreviations, see Archives of Ophth. and Otol., Vol. I., No. 1, p. 242.

day with 10. Later the same reaction produced by 4 El. Left: 2 El. no reaction. 4 El. same as yesterday.

May 14th. Patient feels too miserable to allow of any treatment.

May 15th. Right ear 4 El., no reaction. 6 El. *noises during KS. and KD.* Stronger during An.S. and An.D. *Also on the ear not experimented on, namely, paradoxical reaction.* With 4 El. the same sensations, though weaker in all phases, but without any paradoxical symptoms. Left: same as on the 13th of May.

May 16th. Right: same as on May 15th. Left: 2 El., no reaction. 4 El. KS. weak, during KD. loud tones, as on May 11th. *Paradoxical sensations.*

May 17th. Right: same as on the day before. Left: 2 El. KS. sounds, which increase on changing to An.S. and during An.D. No paradoxical sensation.

May 18th. Right: 4 El., KS. and KD. passing sounds which are prolonged with 5 El. KD. An.S. and An.D. loud noises with after-tones on An.O. Left: 2 El. no reaction with the cathode. Sounds with An.S. and during An.D., with 3 El. reaction in both phases. The duration of each examination was from 2–2½ minutes with from 4–5 times change of the current.

May 19th. Right: the same as on May 18th. Left: with 2 El., weak reaction with An.S. and during An.D. Otherwise same as on May 18th. *Paradoxical sensation.*

May 21st. Right: with 2 El. no reaction; with 4 El. reaction with KS., KD., An.S., An.D., and An.O., the same as on May 18th. *Paradoxical sensations.* Left: 4 El. KS. and KD. Prolonged sounding, which increases with the An.S., combined with the paradoxical sensation on the other ear. An O. also produces reaction. With 2 El. reaction only in KS. *Our patient has subjective symptoms for the first time to-day, at an hour not used for galvanic treatment.*

May 22d.=*May 21st.* *The patient hears her own voice with the left ear during and immediately after the galvanic treatment.*

May 23d. *Patient hears her voice with the right ear.*

May 24th. Same as yesterday; patient hears her own voice with

both ears during the treatment, *and also during the rest of the day. Experiments with whistling give a negative result.*

May 25*th*, 26*th*, 27*th*, 28*th*, 29*th*, and 30*th*. Always the same galvanic reaction, with KS. and KD. weak, with An.S. and An.D. strong sounding. Reaction on breaking the current could never be confirmed. May 27th. Hears deep speech by means of the hearing-trumpet. May 28th. Understands deeply spoken (roared) short words. May 29th. Understands without a trumpet when we speak slowly, syllable by syllable, and in a bass voice close to the ear. Galvanization diminishes the subjective noises in the ear only temporarily. May 30th. Improvement of the power of hearing. For galvanization we use only 2–3 El. on both ears. It seems as if we also had reaction on An.O., although this cannot be positively affirmed.

May 31*st*. All the same.

June 1*st*. Galvanic symptoms as above. We now notice also plainly perceptible reactions with KO., and more plain with An.O. The latter are the stronger. The power of hearing increases. The patient understands now the voice of her little sister, and can hear the rolling of the wagons on the street.

June 2*d*. The same conditions.

June 3*d*.–Examination with the Rheostat by Dr. Moos. Right ear 5 M. El. 190 C.R., KS., and An.S., no reaction.

5 M. El. 200 C.R., KS. sounding.
KD. gradually decreasing.
KO. sounding.
An.S. sounding, but weaker than with KS.
An.D. the same.
An.O. the same.

Left ear 5 M. El., 50 C.R. KS., etc., no reaction.

5 " 60 C.R. positive result in all phases, as right.

June 4*th*. With from 1–3 El. the patient distinguishes plain sounding with KS., KD., KO., AS., AD., AO. The D. = sensations are, according to her statement, much weaker than those of

the S. and O. The patient positively asserts that the sounds at the closing and opening of the current are of different pitch, KS. being of the lowest pitch and An.O. the highest. With KS. a deep tone, KD. deep buzzing, KO. a deep tone, yet not so deep as with KS., An.S. very high sharp tone, AD. ringing, AO. high tone (highest of all). This formula is accurately repeated during the next eight days with the same strength of current. The sensation of sound is so acute that she says it is even painful. The noises diminish gradually in KD., and especially in An.D., but never totally disappear.

June 5th. Exactly as on June 4th; no inconsiderable improvement of hearing. Listening to even rapid speaking does not tire the patient so easily.

June 6th, 7th, 8th. Treatment only in the anode with 2–4 El. Under this treatment the severe subjective noises diminish, never disappear, and return after a short time more severe than before.

June 9th. No treatment. From now treatment every third day only.

From June 10th to 25th. Patient lived in Baden Baden. Continuance of treatment by Dr. Picot and Dr. Von Kraft-Ebing. June 10th. Formula same as June 4th. To-day the noises disappeared entirely in the right ear during treatment, in the left ear nearly so. After the treatment patient has no noises for two and a half hours. The acusticus is less hyperæsthetic. The sensations of sound during galvanization are not so painful. June 13th. Anode during four minutes. Noise disappears in the right ear altogether for two and a half hours.

June 15th. Treatment with the anode. Noise disappears in both ears; right for four hours, left, half an hour.

June 17th. Anode treatment. Noise disappears in both ears. With 4 El. the following formula:—

KS. loud sounding.
KD. ∞.
KO. fine sounding.
AS. no reaction.
An.D. no reaction.
AO. soundings.

From the 18th–24th of June. Daily treatment with the anode. On June 20th, *conductibility of the bones was noticed for the first time.* The watch both sides 2–3 inches. Hearing of speech: Right, four feet; left, two feet. The power of hearing increases slowly but steadily. Hearing is better immediately after the galvanization, when there are no noises. From June 23d no more noises in the right ear.

June 25. Return to Karlsruhe.

June 26. Anode treatment of both ears with from 2–5 El. Right, no more noises; left, they disappear for 24 hours after the treatment. Improvement of hearing.

June 27. Anode treatment of the left ear. Noise disappears for 36 hours.

June 29. Anode treatment of the left ear. The noise disappears until the evening of July 1st, a total of about 50 hours. Improvement of hearing.

July 2. Anode treatment of the left ear. Noises disappear altogether. Dizziness.

July 4. Patient went to Heidelberg. The examination by Dr. Moos showed:—

Hearing distance for watch (30 feet): Right, 40; left, 24 inches. Hearing of speech: Right and left three paces. Conductibility of bones for watch and tuning-forks; the latter, those of high as well as those of low pitch, are heard either through the conduction of the bones or the air, more distinctly right than left. The examination, as to the perception of single notes of the musical scale, shows in the right ear deafness for the two highest, and in the left for the five highest notes of the 7-octave piano. The patient has no more subjective noises. Anæsthesia of the right concha and its immediate surroundings. Normal formula on the use of 12 Siemens-Halske's modified El. and 160 C.R. right, and 280 C.R. left. Patient asserts that she hears a sound of medium pitch, but that on the right ear it is pure and clear, while on the left it is muffled. Immediately after the galvanization, watch was heard, right, 47, and left, 27 inches; speech, both ears, 5 paces.

July 5–11*th.* Daily treatment in Karlsruhe for 1–1½ minute with

2–4 El. in the anode. No noises. Increase of sensibility for the current in the external meatus; sensation of burning. No sensation of sound during treatment. At each sitting frightful dizziness. Hearing improves daily.

July 3.	Right 31,	left 20	Cm.	for	the	watch.
" 5.	" 41,	" 30	"	"	"	
" 8.	" 61,	" 50	"	"	"	
" 10.	" 100,	" 90	"	"	"	
" 12.	" 126,	" 113	"	"	"	
" 15.	" 168,	" 140	"	"	"	

The hearing of speech has increased proportionately.

July 12. Patient visited Heidelberg, and was examined by Dr. Moos. Hearing distance for the watch (30 feet): Right, 10 feet; left, 9 feet. Whispered voice: Right, 4; left, 3 paces. Conductibility of the bones for a finer watch; right plainer than left. In whispered speech the patient hears words with the sound *Ah*, as "Are," "Father," a few paces further than words with the sound *A* as in "Fate," "Ape," etc. Tuning-fork: Right clearer than left, but the difference is not so marked as on July 4th. No subjective sensations of sound. Frightful dizziness on the use of 9 Siemens-Halske's El.; the same symptoms at the second trial, after a pause of several minutes, with 3 S. H. El., and only 10 resistances of the current of the rheostat in the secondary closure. The dizziness nevertheless was of such a frightful character that it was considered advisable to desist from any further galvanization of the ear, resp. the head.

The same violent symptoms occurring in Karlsruhe the next day, after a treatment of $\frac{1}{4}$ minute with 3 El., the patient could consequently, during the next fortnight, be treated only 4 times, and then with very weak currents. July 27th, patient was sent to spend 6 weeks in the Black Forest. There she recovered completely. The last examination made by Dr. Moos, on the 21st of Sept., in Heidelberg, gave the following result:—

Normal acuteness of hearing for a cylinder-watch of 6 feet hearing distance: Right, still inability to distinguish the highest note of the 7-

octave piano. Otherwise hearing is altogether normal. Subjective sensations of sound have not been felt since many weeks. On the left side no anomaly of the sensation of touch. On the right side, notwithstanding an electro-cutaneous treatment, continued for some time, no entirely normal sensation of touch; besides this the following spots are still anæsthetic: the lobules, and a triangular spot, immediately below it, having its apex turned towards the lower jaw, the helix and the upper portion of the fossa triangularis.

Remarks of Dr. Moos.

The case just described offers us many points of remarkable interest.

1. *From the different forms of the disease of the organ of hearing.* On the right side: Paralysis of the auditory nerve, paralysis of the sense of touch, as well as paralysis of the trophic nerves—decubitus of the right concha. On the left side: Paralysis of the nerve of hearing, long-continued hyperæsthesia of the nerves of touch. *All the symptoms* taken in connection with the entire history of the case may be said to have been the result of some *cerebral lesion.* It is true the decubitus of the right concha was in a high degree favored by the continued lying during nine days on the right side. *The stage of paralysis was preceded by a period of increased irritability.* This showed itself by an enormous increase of sensitiveness for all sounds, as well as by a remarkable increase in the acuity of hearing. Perhaps the former was the result of a paralysis, existing at the same time, of that branch of the trigeminus * which goes to the tensor tym-

* See (Beitraege zur Physiologie des Gehoerganges, von Dr. Ad. Politzer).

pani. The latter was, without doubt, a consequence and one of the first symptoms of the beginning participation of the auditory nerve in the intracranial process.

2. *From the manner in which the function of the auditory nerve was entirely suspended.* After the sensation of sounds for objective irritations of every kind had totally ceased the subjective sensations of hearing disappeared also, and remained quiet for several weeks, a striking proof of the complete paralysis of the nerve. For, according to the present standpoint of the study of illusions, it is laid down as a positive rule, that in order to promulgate the existence of a hallucination the integrity of the organ of sense is not requisite, but that the origin of an illusion is absolutely impossible without the aid of an organ of sense.*

A subjective sensation of a nerve of special sense whose function is paralyzed always presupposes at least the possibility of an irritation in the nerve itself by means of pathological changes, but entirely independent of things external to it. A total destruction of the func-

Ueber die Innervation der Binnenmuskeln des Ohres u. s. w. Sitzungsberichte der Wien. Akademie vom 14. Maerz 1861. From the quoted experiments of Politzer we deduce, that the tensor tympani is supplied by the Pars motoria nervi quinti. Helmholtz believes that the tensor tympani has a function analogous to the iris. Perhaps it produces a muffling of the sound. See: Mittheilungen ueber die Mechanik der Gehoerknoechelchen in den Verhandlungen des Heidelberg. Naturhistorisch. Medicinischen Vereins, Jahrgang 1867.

* Compare Wachsmuth: Pathologie der Seele, § 73, and Griesinger: Pathologie und Therapie der psychischen Krankheiten, § 88, II. ed.; besides my essay: Ueber ploetzlich entstandene Taubheit, in the Wien. Mediz. Wochenschrift, 1863, N. 41, 42, 43.

tion, combined with a want of every subjective sensation, is proof positive of the complete paralysis of the sensory nerve.

3. *From the symptoms on the examination and treatment by means of the constant current.*

a. Although a paralysis of the trigeminus existed on the right side, it was nevertheless possible to produce an electric irritation of the acusticus. Notwithstanding the paralysis of the trigeminus in the right side, the irritability of the paralyzed sensory nerve of the same side was continually increased, and finally brought to a perfect recovery by means of the electric current. This proves that in the production of the sensations of sound by galvanization, the promulgation of the irritation is not produced from the ends of the trigeminus, a fact which Brenner,* contrary to the assertions of many other observers,† has clearly proven.

b. Although the auditory nerve was totally insensible to sounds of any kind, it nevertheless showed reaction to electric irritants, even at the moment of greatest deafness.‡

* Compare: Untersuchungen und Beobachtungen auf dem Gebiete der Elektro-Therapie, Bd. I., Abth. I., S. 95-97.

† Among these observers are Schulz and Benedikt. The principal reason why Benedikt believed in a reflex irritation, "was the observation that, cet. par.—e. g., with a sensitive trigeminus—the subjective sensations at least are often noticed with less powerful currents than with a non-sensitive trigeminus" (his Elektrotherapie, p. 270). This observation was confirmed with our patient; but we see from the facts mentioned in 3, that the correct observation of Benedikt cannot be a conclusive proof for his opinion.

‡ This fact must appear natural to every physician acquainted with the

c. As regards the single reactions on the use of the constant current, the acoustic nerve showed, during the different periods of the disease, different kinds of reactions, but not a single one which had not been previously clearly and minutely described by *Brenner* (l. c.). In this respect the entire history of this case only gives additional proof of the reliability of this observer, and especially as regards those observations laid down in the work above cited.*

In the first days we had only a weak reaction of the auditory nerve† with the cathode. Then followed a *period of simple hyperæsthesia* combined with what *Brenner* calls "*paradoxical reaction*" (l. c., p. 401), and finally, a *period of hyperæsthesia with qualitative change* of the formula combined with paradoxical reaction. Only after a long-continued treatment in the duration of the anode did we have a stage with the character of simple hyperæsthesia, and finally, at the time of recovery, the normal formula put down by *Brenner*.

I consider it my duty, on account of the suspicions as regards the accuracy of *Brenner's* observations, to call your special attention to the notes made by my colleague

A B C of the physiology of nerves. Nevertheless it must be urged in opposition to the statements of some aurists.

* I deem it therefore especially important to point to the fact that the electric treatment was conducted by *Dr. Picot*. The Dr. had, up to this time, never treated an ear-patient with electricity; he treated the patient as agreed upon, and took his notes daily, a portion of them before he was acquainted with the monograph of *Brenner*.

† In the commencement we only noticed very undefined subjective sensations of sound, without any character of resonance; then they were called "noises," and only later were they recognized as real "tones."

Picot (especially page 476, May 15), and to compare them with the following remarks of Brenner:—"*Hyperæsthesia with paradoxical formulæ of the ear not under treatment.* The ear not treated reacts exactly as if it were under the influence of the other electrode. In order to produce the reaction in the ear not treated, it is in most cases necessary to use a stronger current than is necessary to produce a reaction in the ear under treatment, or, in other words, there is a minimum strength of current under which the symptom now being discussed does not show itself, and then we only have simple hyperæsthesia. This most remarkable symptom is in most cases combined with a very high degree of hyperæsthesia; but I have also observed it in cases of very little increased irritability. This condition excites the highest interest in such cases where it is complicated with a qualitative change in the formula of reaction. In all cases, but especially in the latter, the superficial observer sees only a seemingly inextricable chaos of sensations of sound; for each of the different movements of irritation is answered by one or both ears, &c."—S. l. c., p. 201, 202, and the following.

We observe: All assertions of *Brenner* are confirmed in our patient; the only exception in this instance is, that the disease is not of long standing, whilst *Brenner*, p. 201, says:—"I have only found this symptom (hyperæsthesia with paradoxical formula of the ear not under treatment) in cases of very old and very serious affection of the organ of hearing." *Brenner* found it very fre-

quently. I myself have until now found it only in positively nervous diseases of the ear, most frequently in deafness after cerebro-spinal meningitis. We will be able to use it, perhaps, at some future time as a diagnostic sign; I myself would not dare to hint under what circumstances. This condition does not give any hints as to the prognosis; I found it even in cases of incurable nervous deafness.

d. *From the beneficial influence of the treatment by duration of the anode, on the subjective sensations of sound.* In the commencement these were only silent during the duration of the anode, only to return after its opening; later they were also silent for several hours after the treatment, and finally they disappeared altogether. We must mention, although it was only exceptional, the fact that once the cathode also seemed to exercise a temporary beneficial influence on the subjective sensations of hearing.

e. *From the violent attacks of dizziness which, notwithstanding all the precautions taken as to the position of the electrodes and the strength of the currents used, occurred in the last days of the treatment.* *Brenner* asserts, with regard to this symptom on the application of the electrodes to the head (l. c., p. 75):—"It is, however, not altogether indifferent how you apply the electrodes to the head when you wish to produce this symptom. You will never produce a dizziness, no matter on what part of the head you close the chain, as long as the imaginary line which connects the two electrodes runs parallel with

the plane which the long axis of the body forms with the long axis of the skull. For the existence of this dizziness it is requisite that the line joining the two electrodes shall form an angle with that plane; and the effect is greatest when the angle is a right one. We conclude from this that the most favorable position of the electrodes for the production of this dizziness is that in which the one corresponds to one half, the other to the other half of the skull. For it is true that the dizziness ceases as soon as the one electrode, in approaching the other, crosses the median line of the skull. *The loss of balance follows, without exception, in the direction which corresponds to the anode.*"

Although I drew *Dr. Picot's* attention to the precautions mentioned by *Brenner*, and I myself followed his directions most precisely, we nevertheless had terrible dizziness. This occurred even in the examination of July 12, when I used the *weakest* current in my apparatus, viz., 3El., and 10 resistances of the current. Was the increased disposition to sensations of dizziness the result of long duration of the galvanization of the head, which was done towards the last only with the anode? Whatever the cause, we can deduce from it the necessity of exercising the greatest caution, and if the case is not very urgent, have intervals of several days during the treatment, as we did towards the last with our patient.

4. *From the manner in which the function of the auditory nerve returned.* In this respect we think the following worthy of mention: The patient first perceived

marked subjective sensations of sound immediately after the use of the current, May 21. These were afterwards present even during the pauses. *The appearance of subjective sensations of hearing, which, as accompanying symptoms of a disease of the ear, have formerly been considered unfavorable for the prognosis, may therefore be, according to circumstances, a favorable symptom in cases of total nervous deafness.* Subsequently, the patient heard her own voice (May 22d) *immediately after* the treatment on the left ear, and May 23, on both ears. May 24, she hears her own voice at times during the day *when not under treatment.* May 27, for the first time, *deep sounds through the trumpet;* on the 29th, without the *trumpet*, and on June 1st, distant noises and high voices. Subsequently the conductibility of the bones returned, and finally, *the highest notes of the musical scale* were also distinguished: The want of conductibility of the bones, even for powerful sources of sound, when the middle ear is intact, can therefore not be considered as absolutely unfavorable, but its return must naturally be considered favorable. All these are symptoms which, from a physiological point of view, must be considered worthy of mention, but need no comment on my part. Finally, we must mention the fact, that even on the day of treatment we could always find a measurable improvement in the acuity of the hearing power, and at last *the improvement and entire removal of all other nervous symptoms* (not belonging to the organ of hearing). In short, *a complete recovery was effected under the use of*

the constant current, with the exception of the anæsthesia of the right ear and its neighborhood, more minutely described above.

Concluding Remarks.

The careful reader will have noticed that in every place, as well in the heading as at the end, I have carefully avoided using the words Cure or Recovery *by* the constant current. Criticism will find in this case a very large field to display itself, more especially because, according to the present standpoint of our knowledge of nervous affections, it is impossible to make a special diagnosis in the disease before us. He who agrees with the altogether general diagnosis of Prof. Kussmaul—I myself have not the slightest idea of differing from it, because to me it seems the most plausible and probable—might observe with the greatest ease: "We were dealing here with an acute rheumatic, or a hysterical, or a rheumatic-hysterical affection of the nervous system, which would have healed spontaneously; the use of the constant current was, therefore, altogether irrelevant. The *vis medicatrix naturæ*, without which the physician in his character as healing artist would be a cipher, has done everything here," &c. This observation I would answer with the generally adopted principle, that *where there is a healing by nature there is also a healing by art*, and I believe that much credit must be given to the effect of the constant current, after a careful and unprejudiced perusal of the history of the case; I believe also that this will be

done by the majority of physicians, who in similar cases —which, it is true, do not occur frequently—will gladly avail themselves of the benefit to be derived from the use of the constant current.

Among the aurists, of course, matters look very differently. Some of them, demigods in their own estimation, and enjoying in certain even scientific circles (probably not much longer) a blind reputation as authorities, have only shown scorn for, or preserved a dignified silence about electro-otiatrics. On the other hand, they have never wearied in filling entire pages in print by upbraiding general practitioners for neglecting the study of ear-diseases.

May this case toll the funeral knell for all those opponents of a therapeutic agent which, when employed according to proper indications, may yet prove a rational and grateful means not only for certain muscular and nervous affections, but also for some ear diseases, though their number may be limited.

MELANOTIC SARCOMA OF THE CILIARY BODY AND ADJOINING CHOROID.

By H. KNAPP.

B. Reinle, seventy-three years old, a healthy-looking widow woman of Schwetzingen, experienced, six weeks ago, some pain in her right eye, and, on closing the left, was surprised to find that she saw very little with the right. The pain increased, the eye became red, and its sight diminished still more, until she presented herself at my clinic in Heidelberg, the 30th of June, 1868. The eye was very much irritated, painful to the touch, and intolerant of light. A great many dilated and tortuous vessels branched over the sclerotic; the conjunctiva, however, was not swollen. The cornea sensible and transparent, anterior chamber of normal size, its contents clear, iris discolored and highly vascular; a number of red streaks radiating from its periphery towards the pupil, enlarging here and there into red round specks. A great many synechiæ united the whole pupillary border of the iris with the anterior capsule, and rendered the latter quite opaque by expanding as a grayish film throughout the pupillary space. Atropine produced no dilatation of the pupil. The tension of the globe was but very slightly increased. There was evident narrowing of the field of vision towards the nose, but its limits could not be determined exactly, the patient being scarcely able to count fingers.

The *diagnosis* was left uncertain. A laxative was administered, leeches were applied to the right temple, and a drop of atropine was

instilled every two hours. The patient remained in bed. Two days later the irritation had subsided considerably, the redness diminished, the pupil was clearing up, and a little dilated towards the nose, the blood-vessels of the anterior surface of the iris had mostly disappeared, the pain was less, the tension of the globe remained the same, the sight had improved to the capacity of counting fingers at three feet distance, and the narrowing of the visual field was better defined. *At the outer ciliary border a detachment of the iris was observed* having 4 mm. in length and about 1½ to 2 mm. in breadth. This *iridodialysis* must have occurred during the preceding night, for the patient had been carefully examined by oblique light every day, and the detachment was so evident that it could not possibly have been overlooked. Nothing was distinguishable in or through the opening made by the dialysis, and the adjoining part of the iris appeared quite normal. With focal illumination a *dark yellowish swelling was clearly perceptible at the outer part of the ciliary region*, close behind the transparent lens, and behind the iridodialysis. It projected with a marked circular outline into the vitreous chamber. On ophthalmoscopic examination the inner half of the pupillary field reflected a dim reddish light, whereas the outer half was entirely dark.

The patient remained under treatment a week longer. The pain in her eye never completely ceased; the vessels continued large and tortuous; the pupil and vitreous chamber did not clear up any further; sight became worse again; and the visual field, when examined with the hand, contracted almost to the point of fixation. In this state I deemed it improbable that longer observation would furnish any additional diagnostic data.

On the 9th of July the patient was examined in the clinic. The symptoms were as above related, and out of their combination the definite diagnosis of *melanotic sarcoma of the ciliary region and adjoining choroid* was derived. Other diseases for which the case might have

been mistaken were discussed. They were, briefly enumerated, the following:—

1. *Glaucomatous Irido-choroiditis.*—The slight increase of tension, the episcleral injection, the restraint of the visual field towards the nose, the dulness of the vitreous chamber, the diminution of sight, the pain, and the sudden appearance of the disease, seven weeks ago, were all arguments in favor of glaucomatous inflammation. But neither the distinct appearance of a yellowish mass at the outer part of the vitreous chamber, nor the spontaneous iridodialysis could be explained by primary glaucoma.

2. *Detachment of the Retina.*—In favor of which spoke the narrowing of the visual field and the spherical opacity in the outer part of the vitreous chamber. But no floating of the retina, none of its characteristic vessels, no decrease of intraocular pressure, and none of the diseases known to induce retinal detachment, could be recognized.

3. *Abscess in Ciliary Region.*—This is not unfrequently met with under symptoms similar to those present in our case. Injuries and foreign bodies in this region cause it very commonly. But the patient had met with no accident, and primary abscess in the ciliary region is extremely rare. I have seen, however, one case in which there was a spontaneous collection of pus exactly in the same region where the swelling appeared in our patient, with this difference, that its color was a brilliant yellow instead of being dusky and opaque.

I enucleated the eyeball. The wound healed by first intention, and the patient was dismissed six days after the operation, free from suffering. She remained under my observation till the end of my stay in Heidelberg, Oct. 1, 1868; but I could not find anything abnormal in her orbit, nor in her general system either.

Anatomical examination of the extirpated eyeball. The freshly enucleated globe, when turned toward a gas-light, proved transparent in its inner half, but opaque in the outer. By turning it around, a dark body, about the size of a hazel-nut, could be seen in the outer portion of the ciliary region and adjoining choroid. I divided the eyeball by an antero-posterior section corresponding to the vertical meridian. Cornea, aqueous humor, and crystalline lens were normal, the vitreous body diffusely opaque, with gray membranes and filaments passing through it. The retina was everywhere adherent to the choroid, and showed no alteration. At the outer part of the *ciliary region and choroid a hemispherical tumor, the size of a hazel-nut*, was seated. Its surface was smooth, black, and shining, being uninterruptedly covered with the membrana ciliaris retinæ, which was continuous with the posterior surface of the apparently healthy iris.

In order to obtain good sections through the tumor and its connecting parts, I hardened the eyeball in Müller's fluid (2 parts of bichromate of potash; 1 part of sulphate of soda; 100 parts of distilled water), and four months afterwards examined it minutely.

The *retina* was normal, and covered more than the

posterior half of the tumor. In the other hemisphere a thin, perfectly transparent, *homogeneous membrane, extending across the vitreous chamber, parallel to the plain of the equator*, was recognized. It was attached to the retina in a circle lying at all points 3 mm. behind the ora serrata, and its insertion was so firm that by drawing on it I was able to separate the retina from the choroid as far as the ora serrata. This false membrane consisted of the finest anastomosing net of large uni- and multinuclear stellate corpuscles, interspersed with physaliphorous cells. In some places the stellate cells lay closer together, and more nearly parallel, so as to form a denser connective tissue. The whole new formation in the vitreous body was a reproduction of its embryonic state, *Virchow's* mucous tissue.

On the surface of the tumor lay a discontinuous, fragile, filamentous covering; the same was found also in some places between retina and choroid, and proved to be granular and filamentous fibrinous deposit.

The *ciliary processes* were everywhere sharply defined, much shortened however at the anterior margin of the tumor, so that all parts of them, except their apices, were lost in the pseudo plasma. The latter had advanced on the outer side of the ciliary processes, and formed an organic union with the peripheral portion of the iris.

After dividing the growth through the middle, I found its antero-posterior diameter to be 14 mm.; transverse diameter 12,3 mm., and thickness 11 mm.

The *cut surface* was granular and black, except on an egg-shaped portion at the outer and anterior part, which was whitish, 7 by 5,5 mm. large, lying like a nucleus embedded in the black mass, which was thinnest (1,3 mm. only) between this nucleus and the sclerotic.

By drawing the cornea backwards the *relations between the tumor and the iris* were discernible. In a small extent of about 2,3 mm. in length, and 1 mm. in breadth, the iris was separated from its sclerotical insertion-line, and united with the tumor in such manner that it seemed to originate in the latter. The defect caused by this detachment was, on the background, filled out with the foreign growth.

The *pseudo-plasma was in uninterrupted connection with the choroid*, out of which it arose in the form of a round, thoroughly circumscribed tumor. The choroid presented nowhere else any abnormities. The retina could easily be detached from the tumor as far as the ora serrata, which adhered to the anterior half of the intumescence.

The *neoplasma was closely connected with the sclerotic*, the lamellæ of which nowhere appeared invaded by it.

Microscopic examination showed the tumor to be a *typical specimen of melanotic sarcoma.* The majority of the cells were spindle-shaped; the processes of many, however, were so delicate that they were broken off by manipulation. In the whitish oval portion the cells had the same character, but were mostly destitute of pigment. In no place was I able to detect any muscular

elements derived from the ciliary ligament, the fusiform cells of the growth distinguishing themselves from smooth muscular fibres by the roundness of their nuclei and the brilliancy of their nucleoli. The ciliary muscle may, therefore, be considered as having been destroyed by the pseudo-plasma. The cells of the latter were largely in excess of the homogeneous intercellular substance, and its bulk was but scantily supplied with blood-vessels.

Origin of the growth and *mode of its progress.* Sections through the margin of the tumor and a part of the neighboring choroid showed that abundant *hyperplasy of pigmented fusiform and oval cells took place from the outer choroidal layers*, without the usual interposition of lymphoid cells. The inner layers of the choroid were preserved and covered the growth to a great extent. The most anterior part of the retina, lying loosely upon the tumor, was in a state of chronic plastic inflammation, presenting augmentation of its connective tissue and infiltration with lymphoid bodies. The sclerotic was closely united to the tumor, so that no interstitial tissue lay between its fibrous bundles and the elements of the neoplasma. In some places, however, rows of small round cells were crowded between the fibre-bundles of the sclerotic, indicating an incipient encroachment of the sarcoma tissue on the sclerotic. Most important was the examination of the anterior portion of the globe, because of its diagnostic value. The inner part of the sclerotic was lined with a dense melanotic mass, extending as far for-

ward as the internal margin of the cornea. There it ceased abruptly, but projected with a smooth surface inwardly, towards the axis of the globe. About 1,3 mm. from the sclerotic, the iris emerged from the black intumescence. Its substance was softened, swollen, and largely interspersed with lymphoid cells—a state of hyperæmia and serous and lymphoid infiltration, which had been noticed already in the living eye, constituting the first stage of inflammation. At the inner angle of the anterior surface of the tumor, a little inwards from the origin of the iris, the stunted ciliary processes were recognized. Their pigment layer was entirely preserved, as well as the connective tissue enveloping the blood-vessels in the interior of the processes. Their vessels were numerous, and connected with those of the external layers of the tumor. They were encompassed in many places by a dense accumulation of lymphoid cells, many of which manifested themselves as sarcoma-cells, having but very small zones of protoplasma around their large nuclei. In addition to their morphological distinctive features, their gradual transition or development into large, well-characterized sarcoma-cells was clearly discernible.

To *review briefly the description of this case*: We find the patient losing her sight under symptoms of internal ophthalmia. The cloudiness of the refracting media, and obstruction of the pupillary field by plastic exudation, made the examination with the ophthalmoscope impossible. Antiphlogistic treatment cleared the refracting media a little, sight improved slightly, a defect of the

field of vision toward the nose was stated, and with oblique light a dark yellowish lump was observed to project from the outer ciliary region toward the optical axis. At this time the iris, just in front of this lump, became detached from the sclerotic, but no pathological formation was recognized to fill out the opening. Upon these data the diagnosis of a melanotic sarcoma of the ciliary body and adjoining choroid was based, which had just passed from its first non-irritative stage into the second, that of glaucomatous inflammation. Melanosis was presumed on account of the dark color of the globular mass within the eye and the age of the patient, choroidal sarcoma in elderly people being probably always of the melanotic variety. The increasing tumor had involved the peripheral portion of the iris, detached it from the sclerotic, and drawn it inwardly. The tumor was a spindle-shaped pigmented sarcoma; its origin the outer layer of the choroid and ciliary body. Its increase followed both modes we observe in neoplasms generally, that of *embryonic development* by infiltration with lymphoid cells (*Virchow's* indifferent or granulation stage), and that of *physiological growth*, multiplication of elements of the mother tissue.

The *peculiar and remarkable features* of this case were, 1. *The detachment of the iris* by the inwardly tending growth. When choroidal sarcoma extends to the ciliary body, its elements crowd forward between the sclerotic and ciliary muscle, throwing the latter, as well as the ciliary processes and their continuation, the iris, towards

the optic axis. Through the opening made in this way, the pseudo-plasma enters the anterior chamber. 2. The *total adhesion of the retina* to the choroid and the tumor, a fact which is at variance with the common belief that detachment of the retina is one of the earliest consequences of intra-ocular tumors. 3. The *formation of a large transparent membrane across the vitreous space, parallel to the plane of the equator*, and firmly connected with the retina, its histologic elements being those of the embryonic stage of the vitreous body, namely, mucous tissue, interspersed with a large quantity of physaliphorous cells.

ON THE PATHOLOGY OF THE VITREOUS.

By Dr. HERMAN PAGENSTECHER, OF WIESBADEN.

Translated from the German by J. H. Pooley, M.D., of Yonkers, N. Y.

On the Question of Inflammation of the Vitreous.

As the views regarding the normal structure of the vitreous have always been an object of earnest discussion, and as it appears the various experiments have not yet led to any definite conclusion, it can only be regarded as a natural consequence if in reference to its pathological actions the most striking differences of opinion have prevailed. Here there were not questions which had reference only to unimportant conditions; no, even such questions were under discussion as might place the whole subject of the pathological changes of the vitreous in a new light. Thus the different investigations on the question of inflammation of the vitreous did not only seek to ascertain how, that is, out of what cell elements the products of inflammation are developed, but they even endeavored to prove that the vitreous is not capable of inflammation at all.

The latter view, formerly defended by *Stellwag*, and in

the year 1860 also by *Ritter*,* was very soon lost sight of. The often-cited treatise by *C. O. Weber*,† the treatise of *Coccius*,‡ and the clinical contributions which have been produced by different authors, seemed to have proved fully the possibility of the existence of an idiopathic *hyalitis* ending in suppuration. It was believed that the existence of connective tissue had been proved, or at least the existence of cells from which pus corpuscles might be produced. This view became immediately so universal that when, in the year 1864, the question was proposed to the Congress in Paris, the most eminent observers present expressed themselves fully in favor of it. Even *Iwanoff* could at that time by his researches upon the normal and pathological anatomy of the eye only arrive at similar conclusions.

Thus it happened that the question in its main point was considered as solved, and that until to-day it is described in all text-books in the same manner. Nor has the theory of inflammation of *Cohnheim*, from the year 1867, which ought in the first place to have influenced the pathology of the vitreous, especially as we have here to do with a tissue destitute of nerves and vessels, had, as it appears, any important influence upon the prevailing doctrine. Only *Iwanoff* has made experiments upon frogs with reference to the results of Cohnheim.

* V. Graefe's Archiv für Ophthal., Vol. VIII., p. 1.

† Virchow's Archiv, Vols. XVI. and XIX.

‡ Ueber das Gewebe und die Enntzündung des Menschlichen Glaskörpus. Leipzig, 1860.

He injected coloring material into the lymphatics, and found, after an artificially produced *hyalitis*, pus cells filled with molecules of the coloring matter. He concludes therefrom that the pus does not originate from the cells of the tissue but from the blood.*

Berlin† also, in his examinations on the passage of foreign bodies into the vitreous, has considered the doctrine of Cohnheim, and after he had refuted an hypothesis favorable to this doctrine, he has nevertheless at the conclusion pronounced the view that the cells of the vitreous and the hyaloid membrane participate in the production of pus. The most recent researches on this subject I take from a résumé in the Centralblatt für die Medicinischen Wissenschaften, 1869, No. 13, über die Abhandlung von G. A. *Blix*, *Studier öfver Glaskroppen Stockholm Medicinskt Arch.* IV., No. 4. The author describes, first, the normal condition of the vitreous, and finds that it has no structure and no other elements, but wandering uni- and multi-nucleated cells with amœboid motions; on irritation, which produce inflammation it is asserted that, as with the cornea, the immigration of the white blood-cells takes place from the vessels of the surrounding tissue.

The now almost universally prevailing acceptance of

* According to the latest observations of *Reitz*, in Vienna, who proved in a similar manner that molecules of coloring matter might be found in the cells and in the intercellular substance, the value of these experiments would be greatly diminished.

† V. Graefe's Arch. für Oph., Band XIV.

idiopathic hyalitis, as well as of the formation of pus corpuscles from the cells of the vitreous, is chiefly based upon the results of the experiments of C. O. Weber. These results were principally gained by experiments on animals. If we examine them somewhat closely we can hardly reach the conclusion which was formerly deduced therefrom. According to my view, at least, it only follows from them that in the vitreous inflammatory products may be found; whether they really are produced there, and furnished by the tissue of the vitreous itself, is another question. Can we, after having inflicted a large wound upon the eye and injected irritating substances, or squeezed out more or less of the vitreous, and thus injured the sclera, choroid, and retina to no small extent, form a conclusion from the resulting panophthalmitis as to the independent inflammatory reaction of the vitreous? The sympathy into which the other organs are thrown is too great to be thus disregarded. The researches of *Ritter* also are open to a similar objection; he arrives, however, at quite a different result, and, as it seems, simply for the reason that, according to his opinion, in the vitreous and retina elements are wanting from which pus corpuscles might be formed.

In the present state of the doctrine of inflammation the problem is to produce independently of the other organs an inflammation or suppuration of the vitreous, or to prove the inability of the vitreous to pass independently into suppuration. To this end I have made experiments on rabbits, by injecting different strongly irri-

tating substances into the vitreous. As is known, every tissue capable of inflammation reacts upon irritation from foreign bodies in a twofold manner, either producing inflammation resulting in suppuration, or becoming encapsulated by the outgrowth of connective tissue. The potency of the irritation plays of course a large part in determining the result; but even upon the slight irritation produced by placing the coagulated white of egg under the cuticle, the surrounding tissue reacts by the formation of a capsule of connective tissue, however thin it may be.

If, therefore, we should succeed in producing an inflammatory reaction by means of a foreign body placed in the middle of the vitreous, be it a suppuration or the formation of a capsule of connective tissue standing in no provable connection with the surrounding membrane, the possibility of inflammation of the vitreous would thus be proved. If, on the contrary, the foreign body produces no clearly demonstrable change, its capability of independent inflammation must be denied. The latter, negative, result would prove much more than the opposite, as against this the objection might still be made that the pus corpuscles had migrated thither along the canal of the wound from the vascular parts. It is just this latter circumstance which renders the determination of the question by experiments so difficult, and becomes the source of so many and such various deceptions. If it were possible to introduce a foreign body or other irritant into the vitreous, without any injury whatever to the surrounding membranes, the question could be decid-

ed forthwith; but as this cannot be done we must, above all, endeavor, first, that the foreign body may lie free in the midst of the vitreous; and second, that as little injury as possible may be done to the surrounding membranes.

Donders sought to attain these ends in a very ingenious manner, by drawing a thread of india-rubber through the eye, putting it upon the stretch, and then cutting off both ends at the same moment, so that the part lying between might shrink into the vitreous. In Zehender's Klinischen Monatsblättern, 1864, p. 323, we find the statement that around such bodies a circumscribed suppuration is formed, unconnected with the surrounding membrane; it is a pity that further communications concerning this point, and especially the appearances upon dissection, have not appeared.

The method I made use of was the following: An extremely sharp and fine canule of a Pravaz's syringe was charged with an irritating substance, introduced into the middle of the vitreous from the front, and then the contents pushed out with a fine wire. The length of the foreign body (piece of wire, glass tube, etc.) was on an average from 5–7 mm.

Care is to be taken in this operation that no wound of the posterior capsule, or the neighboring wall of the globe takes place, and that further, in withdrawing the foreign body from the vitreous itself, it should be slightly depressed. If this latter precaution is neglected, it not seldom happens that the foreign body, probably in consequence of the intra-ocular pressure, follows the di-

rection of the needle, and then either comes in contact with the wall of the bulb, or partially returns into the canal of the wound through the investing membranes; indeed it happened to me twice that it was forced directly out through the wound and buried itself under the conjunctiva of the bulb. Even in spite of these precautions it happens but too frequently that the foreign body, upon the withdrawal of the canule, or often, also, at the expiration of some time, from a sudden movement of the eye, changes from its original situation in the direction of the canal of puncture and comes in contact with the membrane surrounding the vitreous.

In order to observe ophthalmoscopically the reactions of the vitreous under strong irritants, as well as to control subsequently the microscopic section, I modified my experiments in the following manner: A small lymph tube was almost completely filled with croton oil, and in order that it might not be emptied during the introduction the upper end was stopped with wax; it was then put into the canule of a Pravaz's syringe and introduced into the vitreous in the manner described above. The latter would thus naturally be brought in contact with the croton oil in the under end of the tube, and the ensuing changes could be clearly observed with the ophthalmoscope. If the tube was not filled in its whole extent there would be found, immediately after its introduction, commonly a layer of air between the two fluids. This, however, was very soon absorbed, and did not hinder their direct contact. After the section, the

changes which had taken place in the tube could be examined with system 5 and 7 (Schieck and Son).

The entrance of the canule could naturally only take place either through the sclera, or, anteriorly, through the cornea. I made use of the first method in most of the experiments, and as the most convenient from above; the latter was accompanied with too many disadvantages in the wound of the cornea, the escape of the aqueous and lens matter, and the irritation of the ciliary body from puncture of the lens, not to interfere with the simplicity of the experiment, to which is to be added further, the impossibility of minute ophthalmoscopic observations. In only one case among many could I regard the experiment as a success.

It might be proposed previously to extract the lens, and after complete healing of the wound to introduce the foreign body through the cornea; but as I could not promise myself much from this method, I have, in consideration of the completeness of the results obtained by the other method, omitted to employ it.

In the following experiments I shall only bring forward the results of ophthalmoscopic and pathologico-anatomical examination. The general results which I deduce from them will follow. Before, however, I pass on to these, I regard it as necessary, first, to communicate the conclusions which I have arrived at from my experiments as to the normal structure of the vitreous, especially in rabbits. I may, I suppose, here omit the several differences of opinion of the most celebrated observ-

ers as to the structure of the vitreous. I refer on this subject to the treatise of Iwanoff (V. Graefe's Archiv, Band XI., 1).

My experiments induce me in the main to accede to the views of the investigator just mentioned. The correctness of the description of the several cell-forms, and the truthfulness of the illustrations, are, in my opinion, not to be disputed. I only know one point that I might modify, which is certainly not unimportant for the appreciation of the several elements. It concerns the division of the cells into three kinds, namely, round cells, without prolongations, furnished with one or two nuclei; stellate and spindle-shaped cells; and finally the so-called *physaliphorous* cells. My experiments lead me to the conclusion that these must be reduced to one cell-form, and that the one first described by *Iwanoff*.

These are the round contractile cells, with fine granular contents, which sometimes mark, to a certain degree, one or other of the (2–3) nuclei; in respect to their size, form, and action with reagents, they show so decided an identity with lymph-cells that I am as little able to point out any certain marks of distinction between these two forms as between the latter and the white corpuscles of the blood. *Iwanoff* calls them formative cells, and they deserve the name in so far that other cell-forms are developed from them. He himself describes this action, with regard to the second kind of cells mentioned by him, in the following words: "Such cells may be observed as a further development of the first form, and one

may mark among the round cells several with very short outgrowths." By direct observation I have succeeded now in seeing, especially in rabbits only a few days old, the various forms gradually developed from the round cells. This is best done by placing a quite fresh vitreous upon a warm stage. On examination we find, besides the round cells, some spindle and star shaped ones; others with long filiform processes, or with short clavate cells provided with pale-colored projections. If we observe now a round cell, we not seldom succeed in perceiving in the same, suddenly, a little cone-shaped projection consisting of a completely hyaline mass; the same increases either by bulging out, or becomes pointed, and then sends forth one or more processes. This may be developed in two or more spots, and then there arise, after some time, formations which cannot be distinguished from unipolar spindle or star shaped cells. The fine pale-colored processes often exceed ten times or more the length of the original cell; indeed it sometimes seems as if the processes of two neighboring cells had united together. In another instance again, we find a whole bundle of threads of varying length proceeding from the hyaline projection, on which sometimes a small vesicular formation is suddenly developed. If the original hyaline projection does not send out any processes it generally increases, and is then separated from the cell mass by a circular constriction. The above changes of form, which have not been described with perfect minuteness, have reference principally to the hyaline matter of

the cells; but the nuclear contents undergo, at the same time, by these changes a transition of form.

In some cases it is lengthened, in others pushed aside, and then usually appears somewhat more opaque. We have the opportunity of observing the latter sometimes, which happens usually in cells which send forth gradually a single globular hyaline mass, which often surpasses the original cell in size, so that the latter appears, at least the nucleus and the granular contents, as a smaller formation attached to it, and only separated by a circular constriction.

If the latter disappears more and more we obtain a globular formation, on the peripheric zone of which the granular matter, with nucleus, has been deposited like a crescent in shape.

The description, as well as the representation by figures in other places, as in the third kind of the so-called physaliphorous cells, have so great similarity to the cells just mentioned that I believe, especially as I could not find any other similar formations, that here exactly the same elements are found.

I could never convince myself of Iwanoff's conjecture, that the vesicle possessed a membrane of its own. The destination for the secretion of mucus of this membrane has, so far, not been proved by any fact. With regard to the following experiments, I remark, that the examination of the vitreous was always made while it was quite fresh, that of the surrounding tissues usually in a dried state, or after hardening in Müller's fluid.

R. and L. mean always, in the experiments, right and left eye. In referring to the morbid appearances, the ophthalmoscopic examination was relied upon in order to avoid too great length of description, but the relation of the other parts was always mentioned when anything appeared of interest in determining the question.

Experiment 1. *March* 31*st*, 1869. *Afternoon.*

A small gray rabbit; a wire was introduced into the vitreous of the left eye from above, which was free in the midst of the vitreous.

1st April. No change perceptible.

2d April. The lower end of the wire is surrounded by a regular white mass. Upon closer inspection it is found that the upper part also is surrounded by a translucent whitish cloudy matter, from which passes, in the direction of the track of the puncture, a whitish cord with opaque margins, towards the upper wall of the bulb.

3d April. The whitish cloudy matter around the foreign body, and also the cord-like projection above, have become somewhat denser and larger in circumference.

8th April. The whitish mass is larger, irregularly leaf-shaped; in the neighborhood some obscuration of the vitreous; the cord towards the upper part slightly pointed.

Section.—The vitreous is, with the exception of the spot where the puncture was made, completely separated from the other tissue. A whitish cord, becoming thicker by degrees, proceeds from the external wound, a little behind the ciliary body, downwards and forwards, in which the foreign body is embedded. The same shows some enlargement, and passes in the neighborhood of the lower margins of the lens into a thick, yellowish, white mass, which is connected to the ciliary body, at the lower part of the bulb, by a cloudy, slimy matter.

Around the same is found a delicate whitish striped tissue. The cord lies, for the most part, close to the posterior capsule of the lens; likewise the larger part of the thick whitish prominence.

The same is shown by the microscope to consist of fine fibres and very delicate tissue, interspersed with numerous contractile round cells.

The mucus, somewhat cloudy tough matter, which proceeds from the under part of the enlargement towards the ciliary body, contains the same fundamental tissue with contractile cells, and also a goodly number of round, finely granular accumulations of pigment. At the end of the cord towards the wound are found the same elements in a somewhat more distinct striated matrix.

Experiment 2. *March* 31*st*, 1869. *Afternoon.*

A wire was introduced from above into the right eye of a young white rabbit.

Ophthalmoscope.—The wire (even with the naked eye) is visible behind the lens in the substance of the vitreous. The following days no change was to be seen around the foreign body.

April 5th. *Section.*—The foreign body floating free in the vitreous without having produced any macroscopically perceptible change in it.

Experiment 3. *March* 27*th*, 1869. *Afternoon.*

A wire was introduced into the right eye of a large gray rabbit.

March 30th. The foreign body lies in the upper part of the vitreous. Its lower half is enveloped by a cloudy mass, from which a cloudy appearance proceeds in different directions into the vitreous. The upper half is surrounded by a whitish material, which cannot be followed to its termination.

April 1st. The whitish enlargement has grown somewhat in its lower part.

April 7th. The enlargement now entirely surrounds the foreign body.

April 21st. The margin of the enlargement appears somewhat irregular; the cloudiness has, on the whole, slightly increased.

May 3d. The cloudiness somewhat denser in a few spots only, otherwise in statu quo.

Section.—The bulb is opened from behind; in the upper part, on the ciliary portion of the retina, and adherent to the same, is a white plug in which the foreign body is enveloped. It is partially in contact with posterior capsule of the lens. The vitreous body shows, in its middle, round and oval cells, most of them with a very lively amœboid motion. In the situation of the cloudiness a very fine fibrous, here and there finely granular, tissue was perceptible, in which were found large spindle and star shaped, often, also, anastomosing cells. The whole has an appearance similar to embryonic connective tissue.

The separate cells contain one or more nuclei; around them is found a fine granular matter which extends into the projections of the cells. Besides there are present numerous round cells with amœboid motion, which, in their processes, become often deceptively similar to spindle and star shaped cells. In the part bordering on the white mass, the striped ground substance is somewhat more dense and the spindle-shaped cells are more numerous. The plug consists exclusively of pus. The tissue bordering on the canal of the wound is completely filled up with pus corpuscles.

Experiment 4. *April* 24*th*, 1869.

A needle was stuck into the vitreous of the left eye of a large gray rabbit, its upper end projected a little beyond the sclera.

April 26th. The upper part of the vitreous from the place of entrance of the needle to its centre, the surrounding tissue of the vitreous, are found traversed by a blackish finely granular cloudiness; the lower half of the needle is still shining, and the surrounding vitreous quite clear.

April 27th. The cloudiness has increased more below towards the point of the needle, so as almost to reach it.

April 28th The cloudiness has become somewhat denser and more extensive in the upper part; the lower end of the needle is yet free.

April 29th. Point still free.

May 2d. The cloudiness has now reached to the outer side of the point of the needle.

May 3d. The needle is now quite enveloped by the cloudiness.

Section.—The vitreous opened from below. The cloudiness around the needle consists of a fine striped basis matter, in which are embedded many contractile round cells and a dark granular matter.

The translucent cloudiness which envelops the needle below becomes more dense superiorly, the number of the contractile cells at the same time greater. At the point of entrance into the vitreous this matter is connected with the surrounding tissue, and consists exclusively of pus corpuscles.

Experiment 5. *March* 27*th*, 1869. *Afternoon.*

A wire was introduced into the left eye of a little gray rabbit.

March 30th. The foreign body lies in the upper part of the vitreous, only its lower end is visible, and is surrounded by a slight cloudiness, some trails of which proceed deeper into the vitreous.

March 31st. *Section.*—The wire attached to the upper wall of the bulb completely surrounded by purulent matter, which produced cloudiness of the vitreous as already described above.

Experiments 6 *and* 7. *March* 31*st*, 1869. *Afternoon.*

Pieces of wire were introduced into both eyes of a young white rabbit.

Ophthalmoscope.—The same were seen distinctly in the middle of the vitreous; the wire in the right eye had a direction from before backward.

April 1st. No cloudiness perceptible on either side.

April 2d. Same condition.

April 3d. Left eye: from the upper end of the foreign body extends superiorly a dark punctated finely fibrous stripe of the thickness of the foreign body. *Right* eye, no change.

April 6th. A blackish cloudiness like a spider's web has now formed

around the foreign body in the left eye. At the next examination the cloudiness of the left eye has only slightly increased, so that on the 30th of April it is about three times as large as the foreign body; the foreign body itself is still distinctly visible. Right eye, no trace of cloudiness perceptible.

Until the 25th May no other change appeared, except that the cloudiness around the wire in the left eye was no longer as regular but more flocculent in appearance. Right, no change.

May 28th. *Section of right bulb.*—Bulb opened posteriorly; the vitreous appears of normal consistence and is apparently quite clear; upon closer examination we find, however, that a slight mucoid cloudiness extends from the foreign body in the direction of the point of puncture.

One part of the substance of the vitreous, in which the foreign body as well as the cloudiness is situated, is taken out, and it is found that the latter consists of the most transparent finely extended, in many parts irregularly striated, matter, which is throughout interspersed with little points. In many spots striping as well as punctation reddish in color (probably from small particles of oxide of iron, which were introduced into the vitreous with the foreign body); cellular elements of any kind wanting.

Section, left bulb.—Round the foreign body is found a whitish cloudiness which sends a distinct prolongation towards the puncture. It consists of pretty dense, somewhat wavy fasciculi of fibres.

Upon the addition of acetic acid it became somewhat darker, and distinct spindle-shaped cells appeared; besides there are found alongside of the fasciculi of fibres, here and there, contractile round cells.

Experiment 8. *April 27th*, 1869. *Afternoon.*

A little piece of wire was introduced into the vitreous of a young white rabbit, through the cornea and lens, after the pupil had been dilated with atropine.

The aqueous humor emptied itself, and the pupil contracted. Upon

immediate examination it appeared as if the foreign body reached only partially into the vitreous—that, on the contrary, the larger part remained in the posterior part of the lens.

April 28th. Wound of cornea closed; pupil very narrow, irregular; iris strongly protruded forward, somewhat folded, much injected; pupillar region filled by a whitish material.

April 29th. The injection of the iris less.

April 30th. The pupil dilates only from above downward after the application of atropine, synechiæ right and left. The clouded, cone-shaped lens matter which has escaped from the capsule adheres with its point to the posterior wall of the cornea.

Section.—The posterior part of the bulb was removed; we then see that the foreign body is almost altogether in the lens; only a small part has perforated the posterior capsule and reached the vitreous.

From this point a cone-shaped cloudiness extends into the vitreous. Upon examination with a magnifying-glass, we find this to be composed only of drop-like, strongly refracting larger and smaller roundish elements.

The microscopic examination shows variously sized strongly refracting globules, and around and between the same a dark, finely granular, sometimes striated material. The existence of lymphoid corpuscles could not be discovered, neither here nor in the lens matter which surrounds the wire in its greater part.

Experiment 9. *April* 30*th*, 1869. *Afternoon.*

A little piece of wire was introduced into the left eye of a young white rabbit.

Ophthalmoscope.—We observed with some difficulty, after dilatation of the pupil, the lower part of the wire. As it might be surmised that, perhaps, the upper part had receded into the canal of the wound, or at least remained in contact with the upper wall of the bulb, a second wire was at the same time also introduced from above, and luckily into the lower part of the vitreous.

May 1st. The foreign body last introduced lies still free in the vitreous without any cloudiness whatever. Strong chemosis of the upper lid, iris very hyperæmic, great mydriasis.

May 2d. Chemosis less.

May 3d. The wire in the lower part of the vitreous still quite free from cloudiness; the one lying in the upper is more enveloped in a white dense mass.

May 6th. Only to-day a slight cloudiness has also appeared around the foreign body, hitherto free from it, which, as it seems, extends somewhat upwards.

Section.—The cornea and iris were cut away, and the lens removed. The vitreous appears of a soft consistence. The one piece of wire lies in the middle of the anterior part of the vitreous.

Around it is seen, beside some blackish points (impurities), cloudiness quite slight, and hardly recognizable. The same consists of contractile round cells, and of a sparse, fine fibrillated substance in which are found a good many distinct spindle-shaped cells with fine granular contents. Superiorly it passes directly into the whitish mass of pus which adheres to the upper wall of the bulb and encloses completely the other piece of wire. The tissue surrounding both wounds is completely filled with pus corpuscles.

Experiment 10. *April* 30*th*, 1869.

A little piece of wire was introduced from above into the right eye of a young white rabbit.

Ophthalmoscopy.—Only the lower part of the wire could be seen in the vitreous.

May 3d. With dilated pupil, we perceive to-day that the upper part of the foreign body is surrounded by a white material, the other part reaches free into the vitreous; somewhat posteriorly and inwardly there is a pointed elongation of the cloudiness extending into the vitreous.

May 4th. The white matter which proceeds from the foreign body in the upper part of the vitreous has become larger; a broad, some-

what translucent string extends from the same to the lower end of the foreign body; here is found a denser material, blackish or whitish according to the illumination, which again sends forth a slight, thready, punctated cloudiness into the vitreous.

May 5th. The white swelling in the upper part has grown a little.

May 6th. Status idem.

Section.—A white plug of matter proceeds from the upper wall of the bulb, almost completely enveloping the foreign body; from it extends beside the foreign body, even extending beyond it, a white cord with a moderate swelling at the lower part of the vitreous. The same consists of numerous round contractile cells, and a sparser substance, very pale, containing here and there spindle-shaped cells. In the neighborhood of the purulent deposit all the tissues are found to be interspersed with pus corpuscles.

Experiment 11. *April 4th,* 1869. *Morning.*

A lymph tube, nearly filled with croton oil, the upper end of which was closed with wax, was introduced from above into the right eye of a young white rabbit.

Ophthalmoscopy.—We see the little tube standing perpendicularly in the vitreous; the lower end has a dark appearance, with a bright stripe in the middle. During a rapid motion the tube rose upwards a little.

May 5th. The dark portion of the lower part of the tube has almost entirely disappeared; cloudiness is nowhere to be seen.

May 6th. From the upper portion of the vitreous cloudiness extends in different directions; the lower part of the tube is yet entirely free.

May 7th. The upper part of the foreign body is to-day enveloped by a white mass, from which proceeds a striated cloudiness along the tube into a white star-shaped mass, beyond which, however, is still visible the lower end of the tube.

May 8th. The cloudiness has increased.

Section.—The eye is opened from behind, the vitreous appears some-

what liquid, and traversed even in the apparently clear portions by circular contractile cells. The same elements, together with spindle-shaped cells, with fine granular contents, embedded in a very finely striated ground stroma, compose the filamentous cloudiness. The latter stands in direct connection with the mass of pus adhering to the upper wall of the bulb, and enclosing the larger part of the little tube. In the tube is found, at the point of contact between the croton oil and the substance of the vitreous, a dark matter, consisting of many round globules. Cellular formation of any kind could not be found in the little tube.

Experiment 12. *May* 4, 1869. *Forenoon.*

A little tube filled with croton oil, and open at both ends, was introduced from above into the left eye of a young white rabbit.

Ophthalmoscopy.—The tube lies transversely in the middle of the vitreous; at both ends blackish spots are seen.

May 5th. The blackish spots have disappeared. No other change perceptible in the vitreous.

May 6th. Very slight cloudiness in the vitreous, which extends from above to below, and ramifies extensively into the vitreous; it is connected to the foreign body only by the upper end. The remaining part is yet entirely free from cloudiness.

May 7th. The cloudiness has increased; and is densest in front of the foreign body.

May 8th. *Section.*—The bulb opened from above. Consistency of the vitreous normal. A very slight cloudiness extends from the puncture and its immediate neighborhood, towards the end of the tube; the lower part of the same is filled with a whitish cloudy mass, which is proved under the microscope to consist entirely of fine dark granules. Cloudiness in the vitreous shows principally the same character as has been already frequently described.

Experiments 13 *and* 14. *May 4th*, 1869. *Morning.*

A little lymph tube filled with croton oil was introduced from above into the vitreous of both eyes of a young white rabbit.

Ophthalmoscopy.—L. The little tube hangs with its upper end on the upper wall of the bulb; in the afternoon a bluish-white discoloration was visible. R. In the lower part of the vitreous are found two little glass tubes lying crosswise; their contents seem to be emptied out (the original tube was probably broken in the introduction).

May 5th. L. The upper part of the foreign body is enveloped in a cloudy whitish matter. The lower is entirely free in the vitreous. R. Both the foreign bodies lie deep in the vitreous, and have changed their position as compared with yesterday.

A little externally is found at the level of the retina and choroid an oval white spot, in whose vicinity is seen a moderate hyperæmia of the choroid, and some small extravasation of blood.

From the middle of this spot arises a coniform, slightly translucent punctated cloudiness, which passes both the foreign bodies which are lying in the entirely clear vitreous, and extends a little beyond its centre.

May, L. Status idem. R. Only the position of the foreign bodies has changed slightly.

May 7th. L. The cloudy white matter somewhat augmented; lower part of the little tube still free. R. The whitish spot is now, especially in its centre, clearly prominent, and there projects from it the cone-shaped cloudiness. The glass tubes are not connected with the cloudiness, and their ends may be clearly seen.

May 8th. L. Status idem. R. The cloudiness has slightly increased.

May 10th. L. The whole tube is now enveloped in a veil of cloudiness, which, proceeding from the white mass, extends far into the vitreous. R. Upon the prominence situated in middle of the white spot, which reaches somewhat into the vitreous, and where the conical cloudiness begins, there wind from above one, and from below two vascular branches, proceeding from the choroidal vessels. Around the tube not a trace of cloudiness.

May 11th. Both sides status idem.

May 12th. L. Status idem. R. The prominence in the middle of the white spot has decreased a little. Both tubes have again changed their relative position; one appears now to touch by its end the wall of the bulb.

May 24th. L. The cloudiness somewhat increased. R. The vessels have disappeared from the tumor; the latter itself, with the cloudiness proceeding from it, appears to have become a little thinner and denser. The little tubes have again changed their position, so that the lesser one now touches the cloudiness with its outer end; the larger one has attached to the part which already seemed to be in contact with the wall of the bulb, a distinctly conical white tumor, from which a light cloudiness extends over the whole tube. *Section of L.*—The eye opened from behind, exuding clear vitreous, containing a moderate number of round contractile cells. The tube is in contact with the upper wall of the bulb, where a dense cloudiness exists, growing gradually lighter below.

It consists of fine fibrillated lightly punctated matter, with spindle-shaped and numerous contractile round cells.

Section of R.—The bulb opened from before. The larger tube has on its outer end a whitish mass. The same lying in the immediate neighborhood of the ciliary body, yet a definite connection between the two is not macroscopically demonstrable. The part of the ciliary body with the white mass and tube were placed upon the stage, and it was found upon examination that the white mass consisted entirely of pus corpuscles, and that proceeding from the same there extended to the ciliary body a fine fibrillated tissue, containing many spindle-shaped and round cells; the ciliary body at the point of connection was interspersed with round cells. The whitish tumor and conical cloudiness exhibited the composition already frequently described.

Experiments 15 *and* 16.—*May* 9*th*, 1869.

A wire was introduced through the cornea and lens of the right eye of a medium-sized red rabbit. Aqueous humor flowed out.

L. A little tube filled with croton oil, stopped at one end with wax, was introduced into vitreous from above. At the immediate ophthalmoscopic examination it could be seen in the upper part of the vitreous.

May 16th. R. Anterior chamber bulged out; lens matter exuded, and consolidated with the iris and cornea. L. The tube is only distinctly visible at its lower part; the upper enveloped in cloudiness.

May 11th. R. Lens matter very much swollen. L. The tube is no longer to be discovered.

Section of R.—Bulb opened from behind; the cloudiness in the vitreous is most dense behind the periphery of the lens, and there in direct connection with the ciliary body. It consists of fine fibrillated stroma, with preponderating contractile round cells, and a few spindle-shaped cells. The greater part of the lens is clouded and somewhat swollen; in the same the foreign body is stuck fast.

The lens fibres are a little separated at the clouded portion, and numerous large and small globules exude therefrom.

The matter lying round the foreign body consists of entirely disorganized lens fibres, with here and there embedded nuclei and granules.

Section of L.—(The bulb opened anteriorly.) The foreign body lies transversely in front of the wound of the upper wall of the bulb, and is attached to it by a whitish membrane, from which slight cloudiness extends into the vitreous.

The examination of the tube shows that its contents consist of dark, finely granular, strongly refracting matter.

Experiment 17. *May* 11*th*, 1869.

A tube filled with a strong solution of nitrate of silver was introduced from above into the right eye of a large black and white rabbit.

Ophthalmoscopy.—The tube lies in the middle of the vitreous, close behind the lens.

May 12th. A considerable cloudiness extends from above to the foreign body, which continues beyond the immediate neighborhood of

the tube, and is greatest especially in the lower part and round the tube itself.

May 26th. The vitreous appears to be filled with a whitish matter. Bulb very soft.

May 27th. *Section.*—The vitreous is almost entirely filled with pus. The foreign body lies behind the lens. From the puncture extends a pretty thick cord-like mass to the centre of the purulent deposit, consisting of a dense striated material with spindle and star shaped cells, and is traversed by numerous vessels. Contractile cells and granular masses distributed in great number through this tissue.

Experiment 18.

A little lymph tube, filled with croton oil and tapped at one end, was introduced from the side into the left eye of a black and white rabbit, May 26th, 1869, in the morning.

The immediate ophthalmoscopic examination showed the tube lying obliquely in the vitreous, and that the posterior capsule had been injured in its introduction.

In the afternoon, strong chemosis.

May 27th. A circumscribed whitish cloudiness, which seemed to be attached to the foreign body, in the posterior part of the lens.

Section.—Bulb opened from behind. The vitreous is traversed in different directions by fine whitish membranous opacities, all in direct connection with the wound and the neighboring part of the ciliary body. The same are found strongest directly around the foreign body, which hangs free in the vitreous, and is attached at one end to the posterior surface of the lens. The microscopic examination shows a fine striated matter, in many places sown with very fine granulations, and here and there little accumulations like pigmentary granules. Lymphoid corpuscles are only sparsely seen. The little tube was brought under the microscope, and it was found that the croton oil was in direct contact with the vitreous, in which nothing was found but round globules and granules.

Experiments 19 *and* 20. *May* 11*th*, 1869. *Morning.*

Into the left and right eyes of a gray rabbit, air was introduced by means of a Pravatz' syringe.

Ophthalmoscopy.—L. In the upper part blackish hemispherical prominences; cloudiness of the vitreous. R. Above a dark hemispherical mass; no cloudiness.

May 12th. L. A great deal of dark flaky cloudiness floating in the vitreous. R. Only a single large flake. L. The flakes a little more dense, and by their side a fine punctation is seen which extends through the whole vitreous. R. The flake has entirely disappeared, therefore air is again injected. Besides two air-bubbles attached to the upper wall of the bulb, a smaller one is observed in the middle of the vitreous, which has the appearance of a disk with a broad dark peripheric zone, and a bright centre, through which is seen the red background of the eye shining through.

Section of L. in the afternoon. Upon cutting the vitreous a dirty reddish fluid flowed out; this discoloration came from extravasation of blood numerously disseminated through the vitreous; the latter were mostly surrounded by white cloudiness, extending in different directions, especially, however, towards the region of the wound, to be in direct connection with the enveloping membrane. The whitish cloudiness consisted mostly of accumulations of very variously shaped lymph corpuscles, which were sometimes strewn with little dark granules; the majority, however, were filled with dirty yellowish or brownish red contents. Many of the round cells showed still a distinct amœboid motion, and once I could observe how the processes produced thereby extended themselves to a neighboring blood corpuscle, as they spread more and more over it; the latter at last was completely enveloped, and in this manner as it were included.

I found, likewise, in other places distinct roundish cells containing blood corpuscles.

Section of R.—Bulb opened from behind; in the vitreous was found widely diffused cloudiness, which in some places enclosed air. One part of the same, with an air-bubble, was examined microscopically,

and an extremely fine punctated and striated matter was found, which was most distinctly developed in the immediate neighborhood of the air-bubble. Roundish cells were only very sparingly perceived. In the neighborhood of the puncture a little extravasation of blood, showing a similar relation to that described in the preceding dissection.

Experiment 21.

On the 11th of May, 1869, a little piece of wire was introduced into the vitreous of a small black and white rabbit, from below, and thereby the posterior capsule somewhat injured.

May 13th. Some slightly turbid lens matter has exuded.

Section.—The foreign body sticks partly in the lens. Cloudiness extends from the wound towards the part of the foreign body which extends into the vitreous; it consists entirely of roundish cells with an amœboid motion. They contain nuclei, together with dark, strongly refracting granules, which frequently obscure the nuclei.

The cloudiness directly adjoining the posterior capsular wound consists only of disintegrated lens matter, with larger and smaller hyaline globules.

Experiment 22. *May* 26*th*, 1869. *Morning.*

A little glass tube containing croton oil, and closed at the top with wax, was introduced from the outer side into the vitreous of R. of a large white rabbit.

Ophthalmoscopy.—The lower end of the tube reaches free into the vitreous; the other is not visible. The vitreous is as yet separated from the croton oil by a column of air contained in the tube. In the afternoon a whitish discoloration is perceptible around the wound of puncture, and at the same time a diminution of the column of air.

May 27th. A light cone-shaped cloudiness surrounds the tube from its outer portion to its middle. The other end is free in the vitreous. Upon motion of the eye distinct ballottement of the foreign body.

Afternoon. The vitreous is now in direct contact with the croton oil,

as in the middle of the originally empty part of the tube only a little bubble of air is to be found.

May 28th. Air completely disappeared; cloudiness increased, and extends, as a very fine granular appearance, beyond the foreign body deeply into the vitreous.

Section.—Consistency of vitreous good. The lymph tube sticks partly in the canal of the wound of the surrounding membranes, and is surrounded by a whitish cloudiness which extends far into the vitreous. The latter consists of a fine striated material, with numerous lymphoid corpuscles with amœboid motion. In the tube itself croton oil is in contact with the vitreous, and a somewhat dark finely granular matter like an emulsion is here found. Cell elements are nowhere discoverable in it.

Experiment 23. *May* 30*th*, 1869. *Morning.*

A lymph tube, filled with croton oil, closed at one end, was introduced into R. from above, through the sclera, into the vitreous of a large gray rabbit.

Ophthalmoscopy.—It lies nearly in a vertical direction in the lower half of the vitreous; the latter is yet separated from the croton oil by a small layer of air in the tube. The posterior capsule was injured by the puncture. At 4 o'clock P.M. the air layer had decreased more than one-half.

May 31st. Morning. Layer of air has completely disappeared. Cloudiness in the vitreous has not been observed till now. At the point of contact between the croton oil and the substance of the vitreous a small zone of whitish appearance is found.

June 1st. Cloudiness of the posterior part of the lens, and in the vitreous.

Section.—Bulb opened from behind. From the puncture extends a cloudiness, growing denser and broader below, which continues to the pupil and passes over into the vitreous. It appears to be greatest on the upper part of the tube. The latter was taken out together with the surrounding vitreous. The cloudiness consisted of a great

mass of contractile cells of very varying forms, beween which were found in many places a very finely striated material. In the tube itself was found, at the point of contact between the vitreous and croton oil, and extending into the latter, a dark matter containing little highly refracting globules.

Experiment 24. *May* 31*st*, 1869. *Afternoon.*

Air was introduced by means of a Pravaz' syringe into the vitreous of R. of a gray rabbit. The air can be seen by the ophthalmoscope at different points.

June 1st. Air-bubles have disappeared, with the exception of a small one in the middle of the vitreous; distinct filamentous and membranous cloudiness.

Section.—From the canal of puncture cloudiness extends in different directions through the whole vitreous. It consists of numerous lymphoid elements, and finely striated matter disseminated everywhere, which shows in many spots a distinctly membranous layer with very fine points.

Experiment 25. *June* 2*d*, 1869.

The canule of a Pravaz' syringe was introduced into the vitreous of a large gray rabbit, and the same divided in several directions. The immediate examination showed no change.

June 3d. Slight cloudiness traverses the vitreous in different directions.

June 4th. This is to-day more distinct, and near the middle of the vitreous two denser and knob-shaped swellings are to be distinguished.

June 5th. Cloudiness still on the increase.

June 6th, *Section.*—Bulb opened from behind. A slight cloudiness proceeds from the puncture, which passes almost completely through the vitreous. In the same are marked especially two cords, which towards the middle of the vitreous terminate in two whitish swellings, from which again some slighter cloudiness proceeds. Embryonic connective

tissue, besides a large number of contractile round cells, form the principal part of this cloudiness. The tissue around the wound, which is situated near the ora serrata, is completely filled with lymphoid corpuscles.

Experiment 26. *June* 9*th*, 1869.

A little piece of wire was introduced from above into the vitreous of a little white rabbit. It lay, at first, in the middle of the vitreous, but rose afterwards, upon a sudden motion, to the upper part.

June 10th. The upper end of the wire passes into a whitish matter situated in the periphery of the fundus of the eye; here the wire is a little concealed; the other end reaches quite free into the vitreous. From the white point extends a dark, finely punctated, thread-like cloudiness, at some distance from the wire, to the middle of the vitreous, and spreads out into an irregular triangular mass which, upon motion of the eye, floats slightly.

June 11th. The white spot in the periphery has increased; quite a light-pointed cloudiness now extends from it over the whole length of the foreign body, while the cloudiness in the middle of the vitreous has increased considerably in density.

Section.—The foreign body adheres to the upper wall of the bulb, and is there, to about one-half, surrounded by a whitish mass of pus. The other half is free in the vitreous. Beside and a little in front of the same, proceeds, from above downwards, a thick cloudiness beyond the middle of the vitreous. The same contains very fine striated material with contractile round cells. At one spot there was found a very great multitude of cells similar to the so-called physaliphorous cells.

Experiment 27.

A little tube, filled with croton oil and stopped at one end with wax, was introduced into the vitreous of the left eye of a little white rabbit.

June 9th, 1869. The posterior capsule was slightly injured.

June 10th. Posterior part of the lens already somewhat clouded, so that the changes in the vitreous could not be observed with certainty.

June 11th. Status idem.

June 12th. Cloudiness increased.

Section.—The bulb opened from behind. From the point of puncture proceeds a membraniform cloudiness to the posterior capsule of the lens, which consist of a fibrillated substance filled with numerous, here and there oval, mostly, however, spindle-shaped cells, around which is situated a large number of contractile cells. The spindle-shaped cells have mostly a nucleus which becomes more distinct upon the addition of acetic acid, and assumes an irregular shape, and often appears to consist of many corpuscles united together.

The foreign body is most of it in the lens, which appears completely clouded in its posterior part. In the interior of the lens is found a whitish material consisting of very fine dark granules intermixed with oil globules; cellular tissue not discoverable. The ciliary process near the external wound is very hyperæmic, and its tissue completely filled with lymphoid corpuscles.

Experiment 28.

A little piece of wire was introduced from above into the vitreous of the right eye of a little white rabbit.

June 9th, 1869. Forenoon. The same lay in the upper part of the vitreous; not far from it a little air-bubble is seen.

June 10th. The foreign body has changed its position so that only its lower end is visible in the upper part of the fundus of the eye. Slight punctated cloudiness in different parts of vitreous.

June 11th. More diffused cloudiness to-day, with denser filaments, which extend from the foreign body to the middle of the vitreous.

June 12th. Status idem.

Section.—Bulb opened from behind. The greater part of the wire is enveloped in a mass of pus, which is attached to the upper wall of the bulb. From this point cloudiness extends into the vitreous, which consists of contractile round cells and a finely striated stroma.

In the denser filamentous cloudiness are found distinct bundles of embryonic connective tissue with spindle-shaped cells, and around the same all the transitional cell formation to the contractile elements. The tissue around the wound is dense and contains lymphoid cells.

Experiment 29. *June 9th*, 1869.

Air was forced into the vitreous of the left eye of a large gray rabbit, and the vitreous, by the introduction, was lacerated in several directions.

June 10th. Dark, pretty thick cloudiness moving upon any pressure upon the eye.

June 13th. Status idem.

June 14th. Cloudiness somewhat diminished.

June 17th. Again slight diminution of cloudiness.

Section.—Bulb opened from behind. Very fluid, apparently clear vitreous exudes, in which are found, in addition to some red blood corpuscles, contractile round cells in moderate numbers. Sometimes I succeeded in finding one or two red blood corpuscles in the midst of a variously shaped contractile cell. A thread-like cloudiness with some branches proceeds from the wound and extends beyond the middle of the vitreous; in one place it appears of a slightly yellowish red color. Upon microscopic examination it was found that the cloudiness consists of embryonic connective tissue, which is surrounded by contractile elements of varying forms; many of them have very fine reddish brown contents. A large mass of contractile cells is found on the somewhat yellowish red spot, which are mostly of roundish form, and are furnished with finely granular contents, varying in color from yellow to brownish red.

Experiment 30.

Two small lymph tubes filled with nitrate of silver in substance were introduced into the right eye of a large gray rabbit.

June 10th, 1869, in the forenoon. Immediately after the introduction a dense whitish cloudiness formed around one end of the tubes.

At first both lay in the middle of the vitreous; at 12 o'clock, however, they had risen, and there was seen now at the end of each a whitish mass which appeared sharply defined toward the vitreous. In the afternoon the tubes had risen still higher, so that their upper ends were no longer visible.

June 11th. Nothing abnormal to be discovered upon the external part of the eye, except a moderate redness around the wound of the sclera, such as is usually observed after puncture with a needle. Iris reacts well.

Ophthalmoscopy.—The tubes lie still in the upper part of the vitreous; the white lumpy mass on their ends is yet well defined against the clear surrounding vitreous. The more horizontal foreign bodies are in contact with their lower ends, and from this point extends a whitish somewhat striated thread in an upward direction. No other changes could be observed, either externally or by the ophthalmoscope, until the 17th of June.

June 17th. *Section.*—Bulb opened from behind. Perfectly clear vitreous flows out, in which no contractile cells are found. Both the tubes are lying in the upper part of the vitreous, and are joined to one another at their lower ends, and to the posterior capsule of the lens, by a whitish mass; they diverge toward their upper ends, and are there surrounded by a whitish nodulated cloudiness. A white striated filamentous cloudiness proceeds from the wound and passes directly to the point of connection of the tubes, which sends forth in the direction of each of them some further filaments of cloudiness. The whole is removed with the surrounding vitreous. The white color of the cloudiness changes immediately to reddish brown and then to black. Upon microscopic examination it is found that the thicker masses consist of a compact dark mass, appearing finely granular upon its margins, around which, as well as around the tubes themselves, a zone of contractile elements is found, most of them with fine dark granular contents. Besides these the surroundings of these masses were thickly strewn with little blackish points, which gave the impression, on any slight motion of the liquid, of floating upon an invisible membrane. The thread pro-

ceeding from the wound consists of fine fibrous tissue strewn with spindle-shaped cells and contractile round cells, changing into the greatest variety of forms.

Experiment 31. *June* 11*th*, 1869, 11 *o'clock* A.M.

A small lymph tube, partially filled with croton oil, and stopped at its upper end with wax, was introduced into the vitreous of a young white rabbit.

Upon ophthalmoscopic examination it could be distinctly seen in the middle of the vitreous. A small column of air in the tube intervened between the croton oil and the substance of the vitreous. At 4 P.M. the column of air had already diminished one-half.

June 12th. Morning. The vitreous is now in contact with the croton oil; at the point of contact there is a light punctiform cloudiness, which extends somewhat into the croton oil. In the vitreous itself there is not a trace of cloudiness to be distinguished.

June 13th. The cloudiness extending from the point of contact of the two fluids into the croton oil has become thicker. Vitreous itself still entirely clear.

June 14th. To-day also there is no cloudiness discoverable in the vitreous upon the most careful examination. In the tube itself the croton oil has assumed a darkish color.

Section.—The bulb was opened from behind; completely clear vitreous, without even the least microscopic change, flowed out. The tube lay completely free in the vitreous; around the same completely clear vitreous matter was found with the naked eye, and with the strongest magnifying-glass no trace of cloudiness could be observed even in the puncture leading to the foreign body. In the tube itself there was a cloudiness extending throughout almost the entire mass of the croton oil, which was strongest at the point of contact; the substance of the vitreous in the tube was clear. The tube, together with the surrounding vitreous, and the tissue immediately around the puncture, was placed under the microscope and examined. This showed that the vitreous was entirely normal; only reaching from the puncture toward

the foreign body, but not extending quite to it, was found a strip consisting of a row of contractile round cells, lying side by side, in number from six to eight. This clouding in the tube itself consisted mainly of larger and smaller fat globules. The vitreous in the same was completely clear.

Experiment 32. *June* 23*d*, 1869.

A puncture was made into the vitreous of the left eye of a black and white rabbit, through the sclera, from above, with a discission needle. Up to the 26th of June no change in the vitreous was perceptible with the ophthalmoscope.

Section on that day. Bulb opened from behind; perfectly clear vitreous flowed out, and not the slightest cloudiness was to be seen even in the neighborhood of the puncture. The vitreous lying nearest the track of puncture was removed and placed under the microscope, and showed a train of extremely fine light fibres with undulating outline, in which were embedded both round and spindle-shaped and stellate cells, many of which had long processes. The cell contents were pale granular, and in some, on the contrary, black granular.

From the general review of these experiments it follows with great uniformity that nearly always, as the result of traumatic impressions, anatomical, and generally also ophthalmoscopically demonstrable cloudings of the vitreous have developed themselves. The same showed all degrees, from the densest masses to the finest mist-like appearances. The course of the process, and with it the development of the cloudiness, could be traced in almost all cases by means of the ophthalmoscope, and a gradual progression of the same from the puncture in the enveloping membranes towards the centre of the vitreous. Although sometimes the cloudiness was denser or at least more striking around the foreign body, upon

close examination a connection, mostly filiform, could always be perceived with the wall of the bulb. In some cases the cloudiness spread before or laterally from the foreign body deeper into the vitreous, leaving the portion directly around the latter for some time clear and translucent. (Experiments 10 and 26.) Experiment 14 gave an excellent opportunity of observing this relation of the cloudiness opposite to the part of the vitreous occupied by the foreign body in a very striking manner. Here, during the operation either by the canule or the foreign body itself, the wall of the bulb lying opposite the puncture was probably injured; in short, a whitish knot formed in it, sending distinct conical cloudiness into the vitreous; beside the same floated the two glass tubes, whose surroundings appeared nowhere clouded in the slightest degree. The same threw a distinct shade upon the fundus of the eye. Pretty soon vessels from the choroid commenced to be developed upon the surface of the swelling, and extended toward the vitreous. Hereupon followed a diminution of the swelling and a decrease in the density of the cloudiness. All this happened while the foreign bodies were floating in the perfectly clear vitreous, and were constantly changing their situation. This was observed for eight days. At last one of the tubes came in contact with the wall of the bulb, and a thick white cloudiness developed itself immediately at the point of contact.

The foregoing results, mostly obtained by means of the ophthalmoscopic examination, have been carefully proved

by the dissections of the bulbs, which were made in every instance, and the same results were always obtained, that in all cases a connection of apparently the most isolated cloudiness with the point of injury could be demonstrated. Let us turn to the results furnished by the microscopic examinations of the vitreous, together with the cloudiness it contained. In the greater number of cases there could be no doubt that we had to do with products which depended for their existence upon an inflammatory process. The whitish yellow masses, filling in some cases a large part of the vitreous, and in others hanging as small masses to the wall of the bulb, and usually enclosing the foreign body, were always found to be purulent in their nature. The filamentous and membranous cloudiness proceeding from the puncture showed many diversities one from another; this depended partly upon their density, and still more upon the length of their duration. Contractile round cells, with fine granular, often strongly refractive contents, which upon addition of acetic acid showed distinctly one or more frequently constricted nuclei, besides very finely punctated fibres visible only at a few points, were the only appearances noticed in the bulbs earliest examined. The changes of form which resulted from the amœboic motion are so various that it would be very difficult to give an adequate description of them. They very frequently represent the star and spindle shaped form, offering the greatest similarity to the cells of early connective tissue. Judging from preparations which I have taken from

cloudiness of longer standing, there is really no difference between these forms, and thus it is proved that also in the vitreous connective tissue is directly formed from these cells. In this cloudiness is found a fine fibrillated pale undulating tissue, interspersed with star and spindle shaped elements which are sometimes quite pale, in other cases provided with fine granular contents. They frequently send forth considerable prolongations, sometimes giving the impression that the so-called matrix was entirely composed of them. The fibres are usually sharply defined, and here and there arranged in bundles. In the immediate neighborhood of this tissue a great number of round cells, with their changeable forms produced by the amœboid motion, is usually found. In many preparations the transition of the separate formations may be found side by side. (Exp. 28.) If the cloudiness had existed a longer time the lymphoid elements were found only sparingly, and a dense, finely striated, wavy tissue, with spindle-shaped cells, with nuclei distinctly perceptible upon the addition of acetic acid, were found. (Exp. 6.)

These results of microscopic examination confirm likewise the already well-known fact, that connective tissue may, in the vitreous, be formed from the contractile elements, and that, in this manner, the so-called scar formation of the vitreous takes place. There arises now the more important question as to the origin of the lymphoid elements. The same may be found, of course, either in the vitreous itself or in the surrounding tissues. The recent doctrine of inflammation, defended by the fol-

lowers of Cohnheim, is confirmed by the vast majority of my experiments. The connection of the cloudiness with the enveloping membranes, especially in the track of the puncture, could always be anatomically proved; in Exp. 31 there was not, even after three days, the least trace of cloudiness around the lymph tube filled with croton oil, whilst from the point of injury a microscopically perceptible row of pus corpuscles extended towards the upper end of the foreign body, without, however, reaching quite to it. The tissues around the wound showed themselves, in all the cases examined, to be thickly strewn with lymphoid corpuscles. Adding to this the results in regard to the development and increase of the cloudiness obtained by ophthalmoscopic examination, as well as their special relation to the foreign body, results which have been already minutely described, all these facts must lead us to the conclusion that the inflammatory products deposited in the vitreous were formed by the surrounding tissues; indeed they are calculated to make doubtful the capacity of the vitreous for independent inflammation. I may here just refer to the relation of the tubes in the vitreous described in Exp. 14. I will, however, not consider this result yet as proving the latter view.

The objection might be raised here, that a certain inactivity of reaction upon irritation may be inherent to the organ; that impressions made use of were not violent enough, or were not long continued enough; that the capacity for inflammation would diminish with the dis-

tance from the vascular parts, and still other objections might be made. Upon more minute examination of Exps. 7 and 8, this question assumes another form. In both these cases cloudiness was found whose origin was, however, by no means the result of any inflammatory process whatever, as the microscopic examination showed. In the first case the cloudiness consisted exclusively of escaped large or smaller hyaline lens globules, together with ruptured clouded lens fibres, which showed on their external ends a finer striped arrangement. Collections of contractile or other cells could not be demonstrated. In the other case nothing but a more laminated granular, here and there striated, cloudiness was found in the apparently clear vitreous after the operation of the presence of a little piece of wire for fifty-eight days. I do not hesitate to ascribe the same to a chemical influence, as well as to the influence of air which was mechanically introduced along with the foreign body, and consider it, therefore, as a mere product of coagulation.

The difficulty of distinguishing between the latter and fibres of connective tissue is great; indeed in many cases impossible, when both appear together; the complete absence of cellular elements of any kind, and further the circumstance that the most careful daily ophthalmoscopic examination has never shown any cloudiness, as it would have done at the highest point of inflammation; the similarity, moreover, of this formation to those which the cloudiness around air-bubbles produced, proves here that the cloudiness in question must be considered the

result of coagulation. Although these experiments, in connection with the observations communicated above, fully prove that the vitreous does not react, that is, that the accumulation of lymphoid corpuscles is not occasioned at the point of greatest irritation, in our cases around the foreign body, which in every organ capable of inflammation will produce suppuration, or the formation of a capsule of connective tissue, I would not omit to confirm my view by other experiments in which stronger means of irritation were employed, and in which the point of contact of the same with the matter of the vitreous was examined immediately with the ophthalmoscope, and later with the microscope.

This idea led to experiments which I made with the lymph tubes filled with croton oil or nitrate of silver. The ophthalmoscopic changes appearing directly after the introduction of such irritants were, on the whole, very unimportant.

If the tube was closed at its upper end, and not quite filled with the croton oil, the column of air remaining in it showed itself by its dark outline with a brighter stripe in the middle. The resorption of the same followed rapidly often after twelve, mostly after twenty-four hours. Already, during the observation of this process, cloudiness proceeding from the puncture, and extending gradually towards the foreign body, was perceptible in the majority of cases, even if the tube was lying quite free in the vitreous.

In one case, however, no trace of cloudiness was dis-

coverable during the observations of three days (Exp. 31). But here, as well as in all other cases, distinct changes appeared in the tube at the point of contact of the croton oil and the substance of the vitreous. This was very beautifully observed, for at least two days, in Exp. 31. Soon after the disappearance of the column of air, appeared at the point of contact a dark rim in the croton oil, which increased during the next twenty-four hours and became stronger, and spread with diminishing density over the whole mass of croton oil. During this process, the part filled with vitreous remained perfectly clear. After section the above described change was shown, in a strong direct light, as a whitish dense cloudiness traversing almost the whole of the croton oil. The microscopic examination of the tube and surrounding vitreous proves the same to be an emulsion-like mass filled with greater and smaller refracting oil globules and dark granular bodies. The vitreous contained in the tube was always perfectly clear and free from cellular elements; even in those cases where the cloudiness had extended from above beyond the foreign body into the vitreous, if the same is thickly strewn with lymphoid elements, they will also find entrance into the tube itself. I have convinced myself of this by an experiment in which, after the introduction of a tube, by a wire drawn through the developing membranes, I have produced a rapid collection of pus in the vitreous.

In all the experiments mentioned above, the process of clouding was minutely followed with the ophthalmo-

scope, and as soon as it had passed a little beyond the lower end of the foreign body, the dissection was made. The effect of nitrate of silver in substance enclosed in minute glass tubes was only chemical, that is, the formation of silver albuminates, phenomena of irritation depending upon it, were not observed (Exp. 30). By the fact that in the tube itself, at the point of contact between the croton oil and the substance of the vitreous, no lymphoid corpuscles appeared, proof was obtained that the vitreous is not capable of forming pus corpuscles from the forming elements it contains, by the influence of strong irritation. Still further, it is a known fact, that in every organ which we consider capable of inflammation the accumulation of pus corpuscles appears greatest where the irritation is greatest. If we are willing to ascribe to the vitreous an independent power of reaction, that portion which has entered the tube cannot certainly be considered dead; there is not a single reason for such an idea. It is known, on the contrary, that the cellular elements which principally condition the power of life, retain their vitality very easily in such tubes, even outside of the organism. Why, I ask, do we not see any phenomena of inflammation appearing at the point of contact? Why does not the vitreous, if itself not capable of producing pus corpuscles, cause, by some reaction, the surrounding tissues to transfer their lymphoid cells to the point of greatest irritation, as is the case with the cornea (according to Cohnheim)? Why do we see, upon the influence of strongest

irritation, no greater reaction appear than is the case after a simple puncture with a needle? (Compare Exps. 31 and 32.) Why is there not least change in the relation of the vessels of the fundus of the eye after the introduction of nitrate of silver or croton oil? If we add to the conclusions the fact already mentioned, that a piece of wire in the vitreous has not produced any inflammatory phenomena for fifty-eight days; further, the observations which we have frequently made, that the cloudiness does not correspond to the irritation in the vitreous, but may extend in quite a different direction, I think that we may draw the following conclusions from these experiments:—

1st. *That in the vitreous, the gelatinous material, as well as the elements contained in it, be they of what kind they may, are not capable of inflammation from irritating causes sufficient to produce it elsewhere, nor of forming lymphoid corpuscles by morphological changes.*

From this follows—

2d. *That these must immigrate from the surrounding tissues;*

3d. *That the vitreous remains apparently quite passive, even under very strong irritation, or, more precisely, that it is not caused by the same to produce an accumulation of lymphoid corpuscles at the point of irritation, a phenomenon which in a short time follows similar irritation in organs susceptible of inflammation;*

4th. *That, therefore, the vitreous cannot be said to be susceptible of inflammation in the same sense in which we*

use that phrase of other organs, but that every so-called inflammation of it is to be considered as a secondary state depending on the changes in surrounding tissues.

An irritation in the vitreous will therefore only lead to phenomena of inflammation when it exerts an inflammatory influence upon the vascular tissues surrounding that body, and by bringing these into a state of actual inflammation. The products (or exudates) which are developed in consequence of such process are those which traverse the vitreous without regard to the nature of the irritation, and are capable of a further development, *i.e.*, the formation of new tissue resembling ordinary connective tissue; under different circumstances they deposit themselves as purulent accumulations, or are the subject of a retrograde metamorphosis. If it is asked how it is to be explained that the cloudiness usually extends in a regular direction towards the foreign body, and is located especially around it, I believe that it may be explained as follows :—Into the wound inflicted upon the surrounding membranes some particles of the vitreous are always forced by the intra-ocular pressure ; the irritation of the wound produces an accumulation of lymphoid cells which are then brought in contact with the vitreous, and get in large numbers into its substance through the canal of the wound. As proof of this assertion, I refer to the experiments in which a dense cloudiness passed by the foreign body into the vitreous. I had taken the precaution in several experiments to remove the foreign body in the vitreous

from the canal of wound, in order not to produce a simultaneous rising of the same in removing the canule. By this means I had, as it were, made a new passage, and the corpuscles necessarily followed this passage principally. The less disturbed and the more rapid the healing of the wound in the surrounding membranes, the less the products of inflammation which find their way into the vitreous; indeed, under favorable circumstances, they may be wanting altogether, or at least be so insignificant that they escape the most careful ophthalmoscopic and microscopic examination.

II.

CONTRIBUTION TO THE KNOWLEDGE OF OPACITIES OF THE VITREOUS.

As I have had many opportunities during the experiments described to observe ophthalmoscopically the various kinds of clouding of the vitreous, as well as later to examine them microscopically, I will not omit to communicate briefly their results.

Considered from a pathologico-anatomical stand-point, I was compelled to distinguish three perfectly distinct varieties of obscuration of the vitreous.

1st. Such as must be considered as the product of any inflammatory process in the surrounding membranes.

2d. Such as have arisen from an intra-ocular hemorrhage; and,

3d. Such as have been produced by the influence of air or a chemical change.

It is natural that we cannot distinguish in every case any one of these causes alone; on the contrary, we frequently see two, or all three, represented. The cloudiness belonging to the first category shows all degrees of intensity, from contractile cells, only visible under the microscope, generally disposed side by side in a row, as we have seen in Exp. 31, to the denser accumulation of pus, or most pronounced accumulation of cellular tissue. The separate appearances have been mentioned with sufficient minuteness, so that it is unnecessary to refer to them again here. The opacity produced by the accumulation of fat globules may be considered as metamorphosed products of inflammation. I come now to the description of the second variety of opacity. To V. Graefe the credit is due of having first referred to this relatively frequent cause in man; compare his Arch., Vol. I., p. 1. He describes there minutely the ophthalmoscopic relation directly after the appearance as well as during the resorption of the opacities in question. He mentions further, that the duration of the latter has usually been from three to six weeks, several times even some months. These facts received universal confirmation, but the mode of resorption remained still uncertain, and there exists, as far as I know, in the literature of the subject no authoritative experiments on this point. My experiments with rabbits, in which I had opportunity of examining the varying stages of blood extravasations in

the vitreous, as well as two prominent cases in human subjects, seem to me to throw some light on this process. I was led by Langhans's experiments on the absorption of blood extravasations, which he made on rabbits, guinea-pigs, and pigeons, and which he has minutely described in Virchow's Archives, to devote further attention to this subject. Before I enter into a more detailed description of the facts observed, I will describe here especially the one observation on the human being, which appears to me very important in relation to the earliest processes after intra-ocular hemorrhage, and the question of absorption now under consideration, and is also not without interest in relation to the reaction of the vitreous toward foreign bodies.

C. Göbel, 22 years old. Upon the discharge of a fowling-piece, 30th May, 1869, a piece of percussion-cap flew into the right eye. The physician, consulted five minutes afterwards, noticed escape of aqueous humor, and a small wound in the cornea. Two hours afterwards the patient came to this Institute. The eye appeared to be but slightly irritated. In the upper inner quadrant of the cornea was seen a small linear wound, opposite to which there was also a wound of the iris. Anterior chamber normally deep. Pupil moderately contracted; reacts well. By means of the ophthalmoscope some floating cloudiness could be seen in the vitreous; the papilla distinctly visible. Good mydriasis after atropine. The canal of wound could now be distinctly seen in the lens; in the fundus of the eye we observed twice, upon movement of the eye, somewhat to the upper part and outside of the pupil, after numerous examinations, distinctly a reflecting metallic body, apparently of the size of one-third the diameter of the papilla. The same is covered when the eye is at rest by a dense floating obscuration of the vitreous, near which are some other slight opacities.

May 31st. During the night, from time to time stinging pain in the eye, pretty good mydriasis, moderate sub-conjuctival injection, beginning, cloudiness of the lens proceeding from the track of wound. Ophthalmoscopy still the same, only the metallic reflection is no longer visible.

June 1st. Pain increased; therefore enucleation of the bulb was performed. The eye was immediately put into Müller's solution, and on the 12th of June dissected. The bulb is of quite normal form. Cornea in the horizontal meridian somewhat longer than in the vertical. In the middle of the upper and inner quadrant is found a small, slightly bent, light stripe, traversing the thickness of the cornea, over which the epithelial layer is wanting. The iris is no longer to be distinguished clearly. The bulb is divided by a section in the equator into anterior and posterior halves. In the latter there is found, 5 mm. to the upper and external side of the papilla, upon the surface of the retina, a small whitish prominence, from which proceeds a thin white cord, which is still surrounded by a light lymph-like cloudiness finely striated. The thickness of the same is from 2 to 3 mm., and it extends towards the anterior part into the vitreous about 8 mm. in a straight direction. From thence it spreads a little irregularly and funnel-shaped, and encloses a brownish red mass, roundish in form, of from 4 to 5 mm. in diameter, which forms on its anterior extremity a reddish process, which is surrounded by a quite insignificant slightly transparent cloudy mass proceeding from the funnel-shaped opacity. It consists exclusively of red blood corpuscles surrounded by round cells, and the transformations of the same produced by contraction.

A great number of blood corpuscles were also found in the light, cloudy, lymph-like striated matter; at the same time, however, nearly an equal number of round cells, and interspersed among them a number of very small dark granules, here and there collected in heaps. The whiter centre of the stripe shows the same relations, except that the single elements, and especially the round cells, are crowded more densely together. The brownish red mass consists exclusively of well-preserved red corpuscles, with the normal proportions of white ones, which

are surrounded by the funnel-shaped zone consisting of round cells and their metamorphic forms. Besides this specially striking cloudiness in the vitreous we observe another, likewise at some distance from the optic nerve, proceeding from the retina and spreading itself out anteriorly in the form of a membrane. Here are seen embedded small brownish-red spots. With regard to the microscopic relation, these show no deviation from those described in the light string-shaped cloudiness. The small white swelling upon the retina consists of pus corpuscles, and in it is found a piece of percussion-cap 2 mm. in length, and 1½ mm. in width. Fine incisions in the tumor and the adjoining parts of the retina and choroid show the following relations:—Immediately below the purulent mass the tissue of the retina could not be recognized; towards its margin the peripheric layers gradually appear distinctly, whilst the nerve layers and the granular layer are still for the most part filled with pus corpuscles. The latter become gradually less dense until the various layers become again distinct, and were visible only as isolated round cells in the most vascular layers of the retina. The pigment epithelium of the choroid was unaltered, and no change was perceptible in the stroma of that membrane. The anterior half of the bulb contains perfectly clear vitreous.

The posterior capsule of the lens shows, in the upper and inner quadrant, a distinct long oval fissure with a cloudy margin, from which no connection in the direction of the foreign body through the vitreous can be traced.

The connection between the scar of the cornea and the string-shaped cloudiness of the lens, and of the foreign body in the retina, forms a perfectly straight line.

In the *other case* the cornea was burst at its margin in consequence of a blow from a stick, the lens was lost, and a considerable effusion of blood took place into the eye. Extirpation seventeen days after the injury. The dissection took place after induration of the bulb in Müller's fluid for seven weeks. The anterior part of the space of the vitreous, from the commencement of the ciliary process to the posterior surface of the iris, was filled by a large blood extravasation.

Towards the posterior the same was separated by a yellowish white cloudy zone from the other parts of the vitreous. The same consists of fine filaments of newly formed connective tissue, with spindle and star shaped cells, and interspersed with larger and smaller round cells. The latter are especially numerous near the extravasation. They, like all other cell elements, contain a finely granular dark brown material.

Conditions quite analogous with the above described I had the opportunity to witness in my experiments on rabbits in a later stage. After having, with the ophthalmoscope, perceived in the later stages a diminution of the opacities, I could satisfy myself that the number of blood corpuscles had become relatively less; that they had even disappeared altogether in some spots; that, on the contrary, the contractile cells were filled with a matter varying from brownish red to yellowish red. I had several opportunities of observing cells provided with very various processes, in which I could distinctly perceive from one to two blood corpuscles. I have even observed that the red blood corpuscles had been, as it were, held fast by the processes of a contractile cell, and had been gradually absorbed by the same. Besides such variously shaped mostly distinct yellow or brownish red cells, were found, in some cases, distinct traces of young connective tissue.

After all these various observations I believe it may be accepted as true that process of resorption of blood extravasations in the vitreous take place by means of the red blood corpuscles being gradually enclosed in the contractile cells which are furnished from the surround-

ing vascular membranes. The latter change the coloring matter of the same to pigment, and may by further metamorphosis transform themselves into the cells of connective tissue in the vitreous. These observations form, therefore, in general a confirmation of the explanation of the processes of resorption, and especially in the vitreous, which was first described by *Langhans*.

Upon the third and last class of opacities, which may be considered as deposits and coagulations, in my estimation too little stress has hitherto been laid. *Von Graefe* has already drawn attention to the circumstance that the substance of the vitreous exposed to air becomes covered with a fine membrane consisting of a finely granular material. I have had several opportunities during my experiments of examining the cloudiness around bubbles of air, which developed themselves sometimes with striking rapidity, and I found nothing but a striated finely granular material surrounding the air-bubbles; the granules sometimes exhibited a lamellated arrangement, and it would appear sometimes as if the striation of the same had been produced by mere folding.

A very similar appearance is observed in the cloudiness produced by chemical reaction. Different degrees of density were observed in Exps. 6 and 29. In the latter I should like to draw attention to the peculiar process of resorption, which is quite similar to that in cases of blood extravasation. The contractile cells had absorbed particles of the original white silver albuminate, which, after some time, from the influence of light, showed very dis-

tinctly as black grains in the midst of these cells. The cloudiness around the piece of wire, as we have had occasion to observe in the other experiment, has already been minutely described. Such appearances can be very seldom observed, on account of the simultaneous injury of the surrounding membrane; in most cases exudations are found in the vitreous. In our experiment the cloudiness escaped the most attentive ophthalmoscopic examination and could only be proved upon dissection.

V. Graefe was the first to communicate that it may also happen in man under certain circumstances; that the foreign body lies free in the midst of the vitreous without any cloudiness. It is a pity that the results of dissection of such eyes are still completely wanting.

It has been stated from clinical observations and experiments that cloudiness of the vitreous developed itself around foreign bodies without any connection with the internal membranes. I by no means doubt the correctness of these observations; I would only draw attention to the necessity of separating inflammatory products in the vitreous from coagulations of the same, and that we must not conclude in every case in which we see cloudiness appear around a foreign body, that it is the result of an inflammatory process. My experiments, and the facts shown by dissection, compel me to the conclusion, that if as well ophthalmoscopically as later upon dissection no connection with the internal membranes can be proved, the same always consists of coagulation, and never of the products of inflammation.

Cloudiness occasioned by crystals of cholesterin I have never observed in any of my experiments. I would mention in conclusion that this paper, in by far its greater part, has been composed in the spring of this year, at the Anatomical Institute at Marburg. I joyfully take the opportunity of returning my hearty thanks to Profs. *Lieberkuehn* and *Wagener* for the very great kindness with which they placed the conveniences of the Institute at my disposal, as well as to my honored friend Dr. *Langhans*, Lecturer on Pathological Anatomy, for his manifold assistance in preparing this treatise.

WIESBADEN, 16th August, 1869.

INJURY OF THE LEFT EYE; SYMPATHETIC OPHTHALMIA OF THE RIGHT; LOSS OF VISION IN THE EYE SECONDARILY AFFECTED; VISION RETAINED IN THE INJURED EYE.

By THOMAS R. POOLEY, M.D., of New York,

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Ophthalmic surgeons are still divided in opinion as to the propriety of removing an injured eye, while it retains any power of vision, after sympathetic inflammation has declared itself in the other, and progressed to such an extent as seemingly to impair its function.

Cases are to be found scattered through the literature of the subject, in which, under such circumstances, the injured eye has eventually proved to be the more serviceable of the two. McKenzie, in his treatise on Diseases of the Eye, says:* "It is remarkable that the amaurotic affection of the eye which suffers sympathetically, is generally more complete than that of the eye

* McKenzie on Diseases of the Eye. Fourth edition, p. 611.

which was injured." Wells remarks* that, "If some degree of sight still lingers in the injured eye, and the sympathetic inflammation has already produced extensive injury, it should not be removed, for in some similar cases the injured eye has eventually proved of more use to the patient."

The following case is so strikingly corroborative of the correctness of these observations, that I have thought it worth reporting:—

D. M. R., æt. 32, a merchant, consulted me July 6th, 1869. Seven years ago, while breaking stone with a hammer, a piece of steel flew off from the hammer and struck him forcibly upon the left eyelid, through which it penetrated and entered the eye. The foreign body remained for some weeks in the eye (exactly how long he does not remember), and was then removed by his family physician. The wound healed; but two weeks later the eye began to be painful, red, and swollen. A week after the commencement of the trouble in the left eye, the right began to show signs of sympathetic irritation. He first noticed lachrymation, and then temporary obscurations of the visual field; subsequently this eye also became painful, red, and swollen. In two years the right, or sympathetically affected eye, had lost all perception of light. *The sight in the other, the injured eye, now began steadily to improve.*

His condition at the time he came under my observation was as follows:—There was a scar upon the upper

* Wells on Diseases of the Eye, p. 203.

sclero-corneal margin of the left eye, in which the iris was engaged, so as to form an anterior synechia and a pyriform pupil.

The iris, throughout its entire pupillary border, was attached to the capsule of the lens, immovable, and somewhat discolored. The pupil, with the exception of a small aperture, filled with a false membrane.

In the right eye the color of the iris was changed to a dirty green, and a dense opacity occupied the lower border of the cornea. The pupil was completely occluded by a false membrane, and the whole globe somewhat atrophied. Vision in the right eye was completely abolished, there being not even perception of light.

S. in the left eye $= \frac{2}{5}$. Tn. in the left eye; T. somewhat diminished in the right. The fundus of the left eye could be illuminated with the ophthalmoscope, but no details were discernible. For the last four or five years he has had recurrences of ciliary inflammation, with more or less pain in both eyes, *but always commencing in the right, or non-injured one.* The last attack took place about four months before I saw him.

I advised enucleation of the right eye, inasmuch as it evidently was now the source of irritation, and after its removal an iridectomy might with advantage be performed upon the other.

Dr. Knapp, who saw him with me in consultation, confirmed this opinion. The patient, however, refused to submit to the operation, and passed from under my observation.

SEROUS ACCUMULATIONS IN THE TYMPANUM.

BY S. MOOS, M.D.

Translated by C. J. Blake, M.D., Boston.

For the first post-mortem observations upon the presence of serum, with or without mucus or lymph, we are indebted to Toynbee (see p. 227 of the German translation). He was also the first to draw attention to the marked analogy between serous membranes and the mucous membrane of the tympanum, urged the exceedingly small quantity of mucus which it secretes in the normal condition, and demonstrated the same by pointing out the exceeding thinness and smoothness of the membrane lining the tympanum, as also the frequency of adhesions resulting from inflammation in that cavity.

Following Toynbee, Voltolini at different times, in reports of post-mortems upon subjects who had been deaf, published in Virchow's Archives, and, more especially, in his inaugural essay (Examinations of the Ear in the Cadaver, Breslau, 1862), has also particularly described the peculiar characteristics of the mucous membrane of the tympanum as those of a serous membrane.

The first exact communications upon the accumulation of serous fluids in the tympanic cavity originated with Adam Politzer (Diagnosis and Treatment of the Accumulation of Serous Fluids in the Tympanum, Wiener Medicinische Wochenschrift, 1867, No. 16).

In the first case observed by him the diagnosis was facilitated by the membrana tympani not being affected by the disease in the tympanum. Owing to the absence of opacity there remained so marked a transparency of the membrane that the character of the contents of the tympanum could be clearly determined.

Two distinct parts were seen: the upper of a light color, filled with air; the lower darker in color, and corresponding to the fluid collected in the lower portion of the tympanum behind the membrana tympani; the boundary between the two being sharply marked, and distinguished by a fine black line, concave upon its upper border, and extending across from the posterior to the anterior periphery of the annulus tympanicus, at about the height of the middle of the manubrium mallei.

The appearance of this line could be compared to that of a black hair attached to the membrana tympani.

The patient being placed in a horizontal position, in a few minutes the black line changed its place and extended from the superior to the inferior periphery, the difference in color being observed in the anterior and posterior portions of the membrane. On returning the head to its normal position the appearance first observed returned also.

Following the application of an air-douche the difference in color of the membrane disappeared and examination disclosed a number of sharply marked black rings large and small.

The entrance of air into the tympanum occasioned the formation of bubbles in the serum. There could therefore be no doubt as to the diagnosis in this case.

In an article published later (Wiener Med. Presse, 1869, Ueber bewegliche Exsudate in der Trommelhöhle) Politzer again treats of the same subject, and more extensively, upon the ground of numerous observations. He describes the causes of the differing positions of the boundary-lines, their entire absence, and also mentions a characteristic, that, partly from the deflection of the rays of light reflected from the promontory, and partly from the yellowish color of the fluid in the tympanum, the gray color of the membrane is often tinted with a light bottle green.

Some of the patients had the sensation of the movement of a fluid in the middle ear when the head was inclined forwards, backwards, or sideways.

During a personal interview in 1869, in speaking of this subject, Politzer mentioned as a still more characteristic symptom the decided improvement in hearing following the use of air-douche, which, however, generally sank to the original minimum in a very short time, especially when the air-douche was not regularly continued. I have myself had opportunity of observing seven cases of serous exudation into the tympanum; five of

these were on both sides and four were relapsing, so that on the whole the material for observation could not be deemed scanty. In the following pages I shall describe the cases fully, and in conclusion attempt to present an accurate description drawn from the observations which have so far been made upon this subject, so important clinically and therapeutically.

Case I.—*Serous accumulation in the tympanum on both sides. Reported to be the result of a wound. Paracentesis on both sides. Relapse on the right side. Paracentesis repeated. Final recovery. A legal case. Probable misrepresentation concerning the duration and cause of the affection.*

Johann Blind, 31 years old, joiner, sent to me on the 3d of May by Prof. Knauff.

History.—Patient asserts that up to six weeks ago he had never had trouble in his ears. The present attack he refers to a wound of the head received six weeks since in a scuffle. The wound was caused by a blow on the left side with a beer-glass, which broke upon the head, and necessitated his admission into the Academy Hospital; a slight erysipelatous inflammation manifested itself, which was treated, he says, by cold applications for eight days, followed for a short time by warm and then again by cold ones. About three weeks after the accident he states that he became deaf in the right ear, that is, in the side opposite the one on which the wound was received, and in this ear alone.

This trouble has continued without change since that time, and was accompanied by pain deep within the ear, "as if it would rush out." In addition, he has been annoyed by a continued throbbing in the right ear, which increases only on active exertion.

No symptom of otorrhœa; on the other hand, however, he admits, on being questioned, that he has suffered during the whole year from catarrh.

During the last two or three days he has had the sensation of a foreign body in the throat, from which he vainly attempts to free himself by constant "hawking."

Examination.—Numerous scars on the anterior part of the head and on the upper portion of the left side of the face, in consequence of the wound. Both external auditory canals large, and rather straight, without noticeable abnormality. Both membranes present about the same appearances, of a yellowish green (bottle green) color; manubrium nearly horizontal in position, with marked prominence of the posterior fold; centre very concave; continuity of peripheral zone broken. Light spot broadened at its base. Absence of any injection.

The catheter passed easily; auscultation gave a regular bubbling râle on the left side. The resistance to the injection of air on the right side was so great that auscultation was impossible, and the patient experienced positive sensations on this side only when the air-douche was repeated by means of Politzer's method. He exclaimed, "Now it has gone out at both ears."

On both sides the manubrial plexus was now seen to

be injected, more on the left than on the right side however, the light spot somewhat decreased, the umbo somewhat lighter than before.

Hearing before the use of the air-douche:—Perception through the bones of the head on both sides. Voice in a loud tone, on the right side, 3 paces; on the left side, in a whisper, 8 paces. Watch (30 ft., normal hearing distance): Right, 7½ inches; left, 24 inches. After the air-douche, right, 8½ inches; left, 72 inches.

The mucous membrane of the nostrils was flecked with black crusts (patient being a joiner), and reddened. The glands of the pharynx were swollen.

Examination with the mirror showed the posterior wall of the pharynx covered with brownish crusts, and the orifices of the Eustachian tubes much reddened. Beyond this there was nothing of importance. In order to determine whether I had to do with a "malingerer" or no, I examined the patient with tuning-forks, according to the method described in the first number of these Archives.

With both ears free he affirmed that he heard the tuning-fork, when placed upon the head, in the left ear, and with the left ear closed, indistinctly in the right ear. The examination being repeated, he reiterated his former statement.

On the 9th of May I exhibited the patient before the clinic, mentioning previously the possibility of there being dissimulation in the case, and the method for its detection; and on the patient's declaring himself to be

somewhat better, repeated the examination with the tuning-fork, when he stated that he heard the sound equally well on both sides when the ears were free, but only on the right side when the left ear was closed.

May 19th. Patient complains of increased deafness, and of being now affected in the left ear. The watch was heard at a distance of 1 inch, the voice at 2 paces. Conduction of sound through the bones of the head was perfect. The membranes presented the same appearances as before, a boundary-line demarking the level of the fluid in the tympanum from a space filled with air above it could not be distinguished. Nevertheless the appearance of both membranes left no doubt as to the presence of a serous exudation into the tympanum.

Paracentesis was therefore performed in the posterior inferior segment on both sides; the pain resulting from the operation was slight, and the air-douche, as subsequent examination showed, forced a large quantity of yellowish green fluid, mixed with air-bubbles, through both openings. A dark concave boundary-line was now seen at about the middle of the membrane. The hearing distance, tested with the watch, increased on the right side to 3, and on the left to 4 ft.

May 24th. No subjective noises, the perforations closed, and in the place of each a small dry spot of coagulated blood. The tympanic membranes pearl gray, with a "light spot." Hearing distance, with the watch, 15 ft., and the voice, in a whisper, at as great a distance as the room permitted (18 paces).

May 28th. Conduction through bones of the head present, but, without apparent cause, the hearing distance had decreased to 12 inches and 4 paces respectively.

During the last five days, on account of his work, and contrary to orders, he has omitted to present himself for the air-douche. The appearance of the tympanic membranes was the same as before the first paracentesis. The operation being performed a second time, the hearing distance increased to 23 inches and 18 paces for a voice of ordinary loudness; the following day, cicatrices having again formed, to the same distance for the voice in a whisper.

On this day, on examination with the tuning-fork, the patient for the first time gave reliable answers, and said that he heard in a higher tone with the left and in a lower tone with the right ear.

June 3d. The patient returned with a relapse in the left ear. Appearance of tympanic membrane the same as before the first operation. Conduction of sound through the bones of the head present. Watch 4 inches, voice 4 paces. The paracentesis liberated a quantity of yellowish-green serum, and the hearing distance increased up to the following day, when a cicatrix had again formed, to 5 ft. for the watch. There was no demarcation line observable after the operation.

June 8th. No subjective noises. Hearing distance: right ear, 2 ft.; left ear, 10 ft. Appearance of the right tympanic membrane the same as before the first opera-

tion. Following Politzer's air-douche, the hearing distance increased on the right side to 4 ft., and on the left to 15 ft., but without change in the position or color of the right tympanic membrane, etc.

June 20th. Hearing distance on the right side ¼ inch. Conduction of sound through the bones of the head present. Continued rushing sounds in ear. Appearance of tympanic membrane the same as on June 8th. The condition of the left ear was normal.

Paracentesis was performed on the right side, very near the top of the posterior inferior segment. After the use of the air-douche much yellowish serum was found in the external meatus, and the rushing sounds had disappeared. Hearing distance 3 ft. A line of demarcation appeared as before, and the air-douche, repeated five hours later, ejected a still further quantity of yellow serum. The demarcation line then disappeared, and the hearing distance increased to 7 ft. After this visit the treatment consisted in the use of the air-douche, and local remedies to the pharynx; the right tympanic membrane soon regained its normal appearance, and the hearing power on both sides was perfectly satisfactory.

I did not see the patient again till the 10th of August, when he presented himself, and said that up to the afternoon of the 8th of August his hearing was satisfactory in every respect, and he had been perfectly free from all subjective trouble, but after a walk had observed rushing sounds, and a decrease of hearing in the right

ear. Up to this morning the subjective sounds had not disappeared, and at 7½ o'clock A.M. pain commenced behind and under the right ear and in the right temple. The hearing distance was 4 inches. Conduction of sound through the bones of the head present. The whole circumference of the tympanic membrane, the manubrial plexus, and the posterior half of the membrane were congested; the latter was more convex than the anterior portion, which appeared opaque. The light spot was quadrangular. The manubrium rather indistinct.

Paracentesis was immediately performed in the posterior portion, and a quantity of blood, but no serum, ejected. The rushing sounds and the pain ceased. Hearing distance 15 inches.

In the course of the day severe pain commenced, and was alleviated by repeated instillations of warm water. The night was passed without pain, but as often as the patient awoke he felt continued throbbing in the ear.

August 11th, A.M. Severe otorrhœa; the dermoid coat of the meatus raised; tympanic membrane grayish red, the posterior half convex and the anterior concave. The persistence of the perforation was determined only by auscultation during the air-douche; after the use of the latter the throbbing ceased.

August 12th. Moderate discharge. Objective symptoms the same as yesterday. Throbbing, ringing, and stinging in the ear. After the use of the air-douche the hearing distance was 15 inches.

August 13th. The perforation had closed. Occasion-

al rushing sounds and a shooting pain in the ear and temple. The whole tympanic membrane concave, and of a grayish-red color; the manubrium begins to be visible. Following Politzer's air-douche the hearing distance was 25 inches.

August 15th. External meatus and tympanic membrane dry, the latter very concave, the posterior portion and the manubrium congested, the anterior portion opaque. Continuous rushing sounds, and occasional shooting pains in the ear. Air-douche, rushing noises decreased; hearing distance six feet.

August 22d. The subjective noises have permanently disappeared, except that after active exertion he feels a throbbing in the right ear. The patient is free from pain, and is only occasionally troubled by an itching sensation. The circumference of the membrane and the manubrium are still injected, and an examination with a magnifying glass discloses a delicate injection of the radiating vessels. The membrane, which is very concave, is forced outwards by the use of the air-douche, while a distinct concussion is heard with the otoscope. Hearing distance two feet, and the voice in a whisper heard at a distance of eight paces. The patient has not since then presented himself.

This case is remarkable in several respects. The color of the tympanic membranes was characteristic of serous accumulations; the quantity of exudation was, however, so great, that a line of demarcation appeared only after a large proportion of the fluid had been ejected by

means of paracentesis and the air-douche. This excess of the secretion, and the great resistance offered to the passage of air through the Eustachian tube on the right side, prevented the patient from perceiving the effect of the air-douche.

The cause of the frequent relapses is traceable to the fact that the patient, at the time of the treatment, was frequently employed, in following his occupation as a joiner, outside of the workshop during the exceptionally cold and wet June of this year, and a methodical treatment following the paracentesis was rendered impossible. Continued attention should also have been especially directed to the treatment of the chronic affection of the pharynx and nasal passages. In fact, the relapses ceased permanently from the time such treatment was carried out; for the later affection was an acute catarrh, with convexity of the tympanic membrane, etc., a disease of a different character, from which he was speedily relieved by paracentesis.

Concerning the legal points, I would remark that the public proceedings in the case have not yet commenced. In my evidence, however, I shall especially mention that in all probability the patient had an affection of the ear before he received his injury, and would probably seek to take advantage of this circumstance in order to benefit himself pecuniarily.

The affection of the pharynx and nasal passages was undoubtedly of long standing, and the hearing had probably not remained intact. The examination proved

that the patient, who claimed to be deaf only in the right ear, the one opposite to the wounded side, was affected in the left ear also. At first he unquestionably dissimulated; this was clearly proved by the examination with the tuning-fork. Only later, when he found that the existence of his trouble was admitted, and that he was treated therefor,—when, in fact, he no longer feared that he would not be believed,—did he return correct answers when thus examined; this is additional evidence of his former dissimulation. An action for damages, on his part, would be set aside by the laws of any country; in the first place, because as an artisan, having free treatment, he incurred no expense; further, because the affection did not render him unfit for work; and finally, because the organ of hearing was ultimately restored to its normal condition, and neither surgeon nor judge would hold the person who inflicted the wound on the head responsible for the subsequent acute affection.

Case II.—*Serous accumulation in the left tympanum, affording no indications on the tympanic membrane. Paracentesis but once performed. Permanent recovery.*

Mr. D., revenue officer, from Carlsruhe, was brought to me on the 10th of May, 1869, by his family physician, Dr. Deimling. Patient can give no definite explanation of the origin of his trouble. Has been affected for a long time by nasal catarrh, with copious secretion, especially in the morning, and has had a sensation of occlu-

sion of the left nasal passage (a subsequent examination showed this side to be less pervious than the right).

For several years the hearing power in the right ear has not been perfect, but within the last two months has very much decreased, especially on the left side. On this side there has also been a continuous singing noise, sometimes so severe as to interfere with mental exertion, and at times rendering him entirely incapable of following his occupation. He has also had occasional attacks of vertigo.

The hearing distance has decreased to 2 paces for the voice, and 2 inches for a watch of which the normal hearing distance is 30 ft. Conduction of sounds through the bones of the head absent. A tuning-fork placed upon the top of the head heard in the left ear. External meatus normal, manubrium drawn strongly inwards. Membrana tympani exhibits total opacity of the mucous membrane. Color bluish gray, and lustreless; no congestion; light spot diminished. Catheterization was easy, but there was at first great resistance to the passage of the air. The air-douche being persisted in, however, this was finally overcome, and the air entered more freely, causing distinct bubbling râles in the tympanum. The hearing distance increased to 18 paces and 1½ ft. respectively, a result which, according to both physician and patient, had never been attained by any previous catheterization. Each operation followed by improvement in hearing, which did not, however, continue. I expressed the opinion to Dr. D. that there was a serous exudation

into the tympanum, and advised the further treatment of the patient for a few weeks at home. Should there be no improvement I would then perform paracentesis. This advice was followed, but without benefit to the patient. The pharynx was touched with lunar caustic; the nasal-douche, gargles, and Politzer's air-douche employed, and Karlsbad water administered.

May 22d. The patient returned with about the same degree of hearing and the same trouble as before. I performed paracentesis in the post. inf. segment, following it immediately by Politzer's air-douche, and, for the sake of comparison, the catheter also. The injection of air through the catheter was now of course much easier than before, and so much serum was discharged into the meatus that it ran down over the lobule.

Patient heard a whisper the length of the room, and the watch at a distance of 12 inches; the subjective noises ceased almost entirely, and he felt the head to be much clearer. This was at 4 P.M. About 8 P.M. he felt very uncomfortable and had a chill. The night was passed quietly, however, without pain, and with but little subjective trouble. Slight discharge from the ear.

May 23d, A.M. Hearing distance 14 inches, and 10 paces for a whisper.

Communication of sounds through the bones of the head perfect, a small quantity of secretion in the external meatus, manubrium injected and less drawn inwards, slight swelling of the edges of the perforation. On catheterization the middle ear was found to be quite free,

though much serum was still present. Hearing distance 18 inches. The feeling of deafness on the side affected had disappeared. General condition very good; in the evening, however, there was a little feverishness.

May 24th. Perforation closed, watch heard at a distance of 1 ft. Sound in the ear as of distant boiling water. Towards evening an attack of vertigo so severe that I was sent for. The attack continued after he had been placed in bed. Hearing the same.

May 25th, A.M. Following a good night's rest another attack of vertigo. Hearing the same; sensation of itching in external meatus, and the same noise in the ear as yesterday. On catheterization the Eustachian tube was found to be readily permeable. The treatment of the pharynx and nasal passages was recommenced.

May 26th. Less vertigo. Watch heard at a distance of 15 ft., and the voice, in a whisper, at 18 paces (a greater distance was not obtainable). The ticking of a cylinder watch was heard through the bones of the head, and the hearing distance with the same watch was 1 ft. No subjective noises.

The patient remained under my care till June 5th, at which time the hearing was perfectly good, so that the family physician wrote to me to express his surprise at the result. There was but one attack of vertigo during the latter part of the time that he was under treatment; but he was never entirely free from dizziness, and after his return this trouble increased in frequency and severity, although precautionary treatment was continued.

Finally, the administration of Emser Kränchen * having been continued for some time for a chronic gastritis, the vertigo permanently disappeared.

September 5th. I saw the patient for the last time. He rejoiced in his general good health in every respect, and was still in possession of good hearing. He could pursue his occupation undisturbed.

In this case we plainly had to deal with a chronic catarrh of the middle ear. The condition of the mucous coat of the tympanic membrane (see the description of its appearance) had become so changed from this cause that it was impossible to diagnosticate a serous accumulation in the tympanum from examination with the ear-mirror; and this diagnosis was arrived at more from auscultation, and the fact that a marked variation in hearing was observed immediately after the air-douche, and during the pauses following it.

The subsequent improvement in hearing showed that decided changes could not have taken place in the sound-conducting apparatus. The subjective noises and the arrest of perception of sound conveyed through the bones of the head must be traced to increased intra-auricular pressure resulting from the large quantity of exudation, more especially as after the liberation of the same the perception of sounds conveyed through the bones of the head speedily returned, even with a fine cylinder watch, and the subjective noises rapidly decreased. The tem-

* One of the Mineral Springs at Ems.—C. J. B.

porary decrease of hearing power following the cicatrization of the perforation is nothing unusual, and has often been observed in other cases.

The severe attacks of vertigo following the paracentesis are remarkable; exactly the opposite would have been expected; and precisely on this account I do not believe that the cause was to be sought for in the ear, the less so as they entirely disappeared after treatment directed to the relief of gastric trouble. It is difficult to say how long the exudation had existed in the tympanum, but it had probably been present at least two months. Whether serious changes will occur in the middle ear in the future is not easily foretold. Considering the course of the disease during the first three months after the paracentesis, the prognosis in this respect would be rather favorable than otherwise.

CASE III.—*Serous accumulation in the tympanum on both sides; paracentesis on both sides, repeated on the right; otorrhœa of short duration; formation of furuncles in both external ears. Recovery.*

M. M., nine years old, from Philadelphia, was brought to me by his mother on the 20th of March, 1869. The boy had suffered for a long time from a continuous discharge from the nose, copious secretion of mucus in the throat, and for the last few weeks had not been able to sleep with his mouth closed. His hearing, which had been dull "for a long time," had latterly decreased in an alarming manner. On both sides a loud voice could

be heard only at a distance of two paces, and the watch (normal hearing distance, thirty feet) at a distance of nine inches. Conduction of sound through the bones of the head was present for the watch only. The upper lip was excoriated by the continued discharge from the nose, and the mucous membrane of the latter very much inflamed. Breathing through the nose was accomplished with difficulty. On depressing the tongue, the tonsils and glands of the mucous membrane, at the back of the pharynx, appeared swollen, while at the same time a quantity of mucus was forced down from the upper part of the pharynx by the pressure on the tongue. There was no trace of injection on the tympanic membrane or manubrium, which was drawn strongly inwards on both sides. The tympanic membranes were very concave, of a peculiar blue-black color, and very transparent.

With common illumination, and still more clearly by reflected sunlight, there was seen on the right side a grayish black line, concave, and passing from before backwards across the end of the manubrium. It had the appearance of a "grayish black hair," fastened upon the mucous coat of the membrane; the coloring of the membrane was different, being more of a yellowish green. Treatment with Politzer's air-douche, continued for three days, resulted in a decided improvement in hearing. On the 5th of April, however, this had decreased to its former minimum. April 5th, I performed paracentesis on the right side, following it immediately with the air-douche, which was repeated several times up to the 9th.

On the 5th and 6th a quantity of straw-yellow stringy secretion was discharged. On the 9th, an examination with the mirror and test of hearing-power showed apparent return to the normal condition. I then performed paracentesis on the left side, and in this case the demarcation line showing the level of the fluid appeared only after the operation. Otorrhœa and circumscribed inflammation in the external meatus, accompanied by severe pain, followed. This condition existed on the 15th of April. After closure of the perforation, which occurred on the 13th, the air-douche was continued every day till the 17th, then omitted till the 21st.

The condition of the right ear on that day was unfortunately the same as before the first paracentesis—the same in every respect except that the quantity of serum appeared to be greater, as there was no line of demarcation.

I repeated the paracentesis with the same result as before, except that a line of demarcation was not at this time observable. A quantity of fluid, presenting the same appearance as before, was, however, ejected.

Otorrhœa and follicular abscesses in the external meatus followed this operation also, and it was not till the 28th of April that the normal condition returned. The subsequent treatment was directed to the condition of the pharynx and nasal passages.

This case is noticeable inasmuch as the loss of hearing was the same on both sides, notwithstanding the great difference in the quantity of the secretion; the degree of

deafness, therefore, does not depend entirely on the amount of fluid secreted, especially in cases accompanied by impermeability of the Eustachian tube. The relapse, and the occurrence of suppuration in the tympanum after paracentesis, are worthy of notice. The latter was probably the result of the operation and the follicular inflammation in the meatus.

CASE IV.—*Serous accumulation in the right tympanum. Small quantity of serum. The demarcation indicated by two divergent descending lines. Paracentesis. Subsequent otitis media and formation of furuncles in ext. meatus.*

Mr. S., school-teacher, consulted me on the 1st of June, 1869. According to his statement (which was confirmed by subsequent examination), he has been deaf in the left ear for the past two years, without any cause of which he was aware, and has also been troubled by continued subjective noises. Up to the 27th of May the right ear was in normal condition; at that time he took part in a procession on Corpus-Christi day, perspired freely, especially about the head, and was exposed to a draught of air. On the 29th severe vertigo occurred, rushing sounds, and loss of hearing on the right side. There has been no improvement in any of these symptoms, with exception of the rushing sound, which is not continuous, as it was at first, but occurs only occasionally.

Examination.—Hyperæmia of the inner end of the external meatus and the manubrial plexus, the superior half of the tympanic membrane lustrous; through the

lower half there can be seen a collection of fluid in the tympanum, and the appearance is exactly the same as that described by Politzer and given in the second illustration of his work. The fluid was bounded by two lines, commencing at the lower end of the manubrium and diverging with a slight curvature downwards. Conduction of sound through the bones of the head; the examination with the tuning-fork was without definite result. The voice was heard at a distance of 5 paces, and the watch at 1 ft. (in place of 30 ft.). Paracentesis was performed, and a small quantity of serum, but a good deal of blood, came through the opening. Hearing distance 2 ft. The diverging lines of demarcation have disappeared. The operation was immediately followed by pain, sense of fulness in the head, and a rapid injection of the whole tympanic membrane, and later a copious discharge and active inflammation of the membrane and the tympanum. The perception of sound through the bones of the head was lost, a steady rushing sound came on, and the hearing distance decreased to 3 inches.

June 7th. Abatement of the preceding symptoms.

June 8th. Symptoms of circumscribed inflammation in the external meatus.

June 12th. Freedom from pain, no discharge, and no subjective noises. Meatus still somewhat occluded. Perforation closed. Hyperæmia about the manubrium; tympanic membrane grayish red. Hearing distance 2 ft.

Perception of the voice is so good that the patient will await the further development of his case at home.

In the above case the peculiar appearance of the memb. tymp. is remarkable; as yet I have seen it only in this one instance. Politzer explains it by the supposition that the quantity of fluid in the tympanum being small, it is distributed in the situation described by the adherence of the approximated surfaces of the central portion of the tympanic membrane and the promontory.

So great a degree of disturbance in hearing would hardly have been expected from the presence of so small a quantity of fluid in the lower part of the tympanum, and this gave rise to the suspicion that the right ear had not been in a normal condition for some time previous to the acute attack (such had been the case in the left ear for two years).

The otitis and formation of furuncles which followed the paracentesis I trace to that operation. Though I may consider the result in the hearing gained to the patient a satisfactory one, because being totally deaf on the left side his occupation as a school-teacher obliged him to depend upon his right ear, still I freely confess that in a like case I should not be so ready in performing paracentesis, at least till I had made the attempt for a sufficient length of time to determine whether or no so small a quantity of fluid could be removed without the assistance of an operation. In this connection I would especially remark, that at the time of my treatment of this case I was not aware of the experiment advised by Politzer in his second article on this subject, the head being thrown backwards or bent far forwards during the air-douche.

CASE V.—*Serous accumulation in the tympanum on both sides. Paracentesis on both sides. Hearing restored. Continuance of subjective noises on the left side.*

S., 29 years old, merchant, from the Palatinate, consulted me for the first time on the 25th of May, 1869. Has been troubled for several years with "catarrh and mucus in the throat;" for the last five years has had trouble in his ears. At the commencement he was first affected with a rushing sound in the left ear; there were long pauses, however, so that sometimes for half a year he would be without subjective noise or diminution of hearing, and it is only lately that he has experienced loss of hearing on the right side. Subjective noises have never been present in this ear. In both ears the meatus is normal in every respect, and there is no sign of injection either in the tympanic membrane or about the manubrium mallei. The right membrane is very concave, the posterior portion grayish green, the anterior of a tendinous white color, the light spot broadened.

The left tympanic membrane is furrowed at its periphery, and exhibits numerous light spots. The post. half appears grayish yellow, the anterior tendinous white. No demarcation line on either side. Hearing distance, right side 6 inches (in place of 6 ft.), left side, with the watch, 1 ft. (in place of 30 ft.). Voice at a distance of 6 paces.

Great resistance to the injection of air with the catheter; on both sides fine seething and bubbling râles were heard on auscultation. Hearing distance, right ear 1 ft.

(in place of 6 ft. with a common watch), left ear 4 ft. (in place of 30 ft. with a test watch).

On the right side the common watch, and on the left side only the test watch are heard through the bones of the head. Tuning-fork heard in the left ear when placed upon the head. I advised the patient to put himself under my care for a short time.

June 3d. He came to me in about the same condition as before, and the air-douche had the same result as at the first visit.

The next morning I exhibited the patient to the class, gave the reasons for a diagnosis of a collection of serum in the tympanum on both sides, and performed paracentesis in the post. inf. segment of both membranes. The operation was followed by Politzer's air-douche. A quantity of yellowish green serum was forced out on both sides, and in the left ear ran down over the lobule. A concave line of demarcation was now seen, extending from the end of the manubrium across to the posterior periphery; the anterior half of the membrane was evidently too opaque. More serum being ejected, the line of demarcation disappeared. Hearing distance, right ear 12 inches, left ear 15 ft., and with a common watch 3 inches. Subjective noises lessened, but have not wholly disappeared. Manubrial plexus somewhat injected.

3 P.M. Hearing distance on both sides the same as in the morning; appearance of manubrial plexus also the same. The tympanic membranes of a silk gray color,

shining, but the numerous light spots have disappeared from the left side.

The perforations still exist. Air-douche repeated.

June 5th, A.M. Both perforations cicatrized. Commenced treatment of the pharynx and nasal passages according to the usual method. Air-douche continued.

June 7th. A common watch heard at a distance of 12 inches in the right ear, and 7 inches in the left.

Subjective noises in the left ear continue. Air-douche by means of the catheter on the left side. Hearing distance, 11 inches.

June 11th. The patient had the normal degree of hearing in the right ear, and 4 inches in the left. A common watch was heard through the bones of the head, and the perception of common conversation was excellent, but the noises in the left ear continued. He was instructed in the use of Politzer's air-douche, and advised to employ it three times a week, and to report himself on the appearance of the least trouble in the ear, but up to this time has not presented himself.

In the preceding case we had a catarrhal inflammation of the middle ear, of long standing, to which was subsequently added a serous exudation into the tympanum, on both sides. As proofs of the long continuance of the trouble in the middle ear, we have the fact that the characteristic coloring of the tympanic membrane was not seen over the whole surface, because a portion of the mucous coat had become very opaque; and for the same reason the line of demarcation which occurred on

the left side, after liberation of a portion of the secretion, was only visible through the posterior half of the membrane; and in addition, the persistency of the rushing sounds, which remained in the left ear at the conclusion of the treatment, and the diminution of hearing power in this ear as compared with the right.

The mucous membrane of the tympanum, from long contact with the exudation, had evidently undergone changes which would not permit perfect restoration, a circumstance which, taken in connection with the persistence of the subjective noises, tends to make the prognosis for the left ear rather unfavorable, and leads to the apprehension of the development, slow but progressive, of a chronic catarrh of the middle ear.

CASE VI.—*Serous accumulation in the tympanum on both sides. Absence of the characteristic appearances of the membrana tympani. Paracentesis and relapse on both sides, followed by the first appearance of characteristic symptoms on the left side. Repetition of the paracentesis on both sides. Repeated myringitis, resulting from the operation on the right side.*

Valentin Füg, 25 years old, trumpeter in the dragoon regiment in Bruchsal, consulted me on the 8th of June, 1869.

For thirteen weeks has had trouble in both ears, incapacitating him from duty.

The affection was preceded for some time by "cold in the head, and catarrh;" commenced with noises in the

ears, first on the right, and then on the left side; finally this ceased on the left, but has continued up to date on the right side. The hearing decreased in an alarming manner, and latterly the tones of his instrument have been a torture to him; at first he believed that his comrades were playing out of tune.

Examination.—The form of the external meatus, on both sides, was such that it was impossible to get a view of the anterior inferior segment. So far as can be seen, the inner end of the meatus and the manubrial plexus on both sides are injected. The tympanic membranes are very concave, opaque, and indicate the presence of serum; on both sides the manubrium is nearly horizontal, beyond this nothing of importance. Hearing distance, right ear, 5 inches; left ear, 7 inches. (Test watch of 30 ft. hearing distance.) Conduction of sound through the bones of the head present. On catheterization there was at first great resistance to the entrance of air, especially on the right side; finally, however, a fine bubbling rattling râle was heard on the left side; at first a creaking sound only was heard; this remained on the right side, but changed as above described on the left.

The hearing distance increased on both sides to 4 ft., and the sounds disappeared.

June 10th. Hearing has decreased, but the subjective noises have not returned; the air-douche was repeated with the same result as before, but on the 18th of June the hearing had become as bad as before the first treatment, and the sounds returned with the same intensity.

Notwithstanding the absence of any appearance characteristic of a collection of serum in the tympanum, I considered that such was the case on both sides, judging from the results of the auscultation and the variation in hearing power before and after the use of the air-douche. I performed paracentesis in the posterior inferior segment on both sides. Following Politzer's air-douche, a quantity of a wine-yellow fluid appeared on the outside of the left membrana tympani; on the right side the only change was in the disappearance of the noises. There was no trace of fluid, and it made its appearance only on a repetition of the air-douche, and then in as large a quantity as from the other ear. After removal of the fluid, the edges of the perforation in the right ear were seen to be colored with blood. Hearing distance 20 feet. A common watch was heard at a distance of 11 inches in the right, and 9 inches in the left ear. Three hours later the perforation on the left side appeared to have closed. The noises had disappeared, the external passages were dry. The air-douche was repeated with positive and negative results on the left and right sides respectively. It was necessary to catheterize the right side before getting subjective and objective symptoms of the passage of the air. There were no rattling râles perceivable. A common watch was heard at a distance of 13 inches. This degree of hearing was retained at the date of the next visit on June 21st, by which time the perforation had closed.

Severe pain, with rushing and pulsating sounds, com-

menced in the right ear on the evening of the 18th of June, together with a discharge which has continued up to the 21st. The memb. tymp. was grayish red in color, covered with pus, and having a pulsating bubble in the perforation. Politzer's air-douche was employed without result, and the catheter was necessary to clear the passage. The noises were silenced, and the hearing distance increased from 1 to 4 inches (tested with a common watch).

June 23d. Hearing distance, right ear, 4 inches; left ear, 18 inches. No return of pain; a rushing sound in the right ear, but no throbbing, and but slight discharge. Appearance of memb. tymp. the same as at last examination.

Politzer's air-douche was employed without result on the right side; but after catheterization the hearing distance increased to 6 inches, and the noises disappeared.

June 30th. Since the last visit the patient has performed with his band several times—twice till long past midnight—and in addition to this has led a very irregular life. The rushing noises have returned on the right side, and the hearing has decreased to 1 inch; on the left side to 5 inches.

The appearance in the right ear is the same as it was before, while the left memb. tymp. has a peculiar earthy color, is very concave, the light spot dim, and the manubrium prominent. There is no line of demarcation.

Politzer's air-douche was perceived in the left, but not in the right ear.

Hearing distance on the right side 2 inches, on the left side 7 inches, without essential influence on the condition of the left memb. tymp. The use of the catheter in the right ear forced a passage and increased the hearing to 4 inches. Paracentesis was performed in the posterior inferior segment on the left side, and followed by Politzer's air-douche, which was perceived in both ears. A quantity of stringy serum was found in the left ear. Hearing distance on the right side 5 inches, on the left side 12 inches.

July 3d. Left tympanic membrane normal in position and color, with a brown spot upon the cicatrix of the perforation. Hearing distance 26 inches. A common watch was heard in the right ear at a distance of 1 inch. No perforation, and the secretion has ceased. Memb. tymp. of a grayish-red color ; manubrium not yet visible. Continuous rushing noises. Politzer's air-douche without result. The use of the catheter increased the hearing distance to 4 inches, and gave the same results on auscultation as at the first visit.

July 10th. The same. At this visit the injection of air could be accomplished neither with Politzer's air-pump (compressed air at a pressure of from 1 to 1½ atmospheres) nor with the catheter. Hearing distance 2 inches. Conduction of sound through the bones of the head present. Memb. tymp. is still covered. Paracentesis was again performed in the posterior inferior segment, and Politzer's air-douche employed, but still without result. Catheterization forced out a quantity of a reddish-yellow fluid, the

rushing sounds disappeared, and the hearing distance increased to 6 inches.

July 11th. Hearing distance 4 inches. Occasional rushing noises at intervals of several hours. Fresh symptoms of myringitis.

July 14th. The same. The perforation remains. Hearing distance 6 inches. Continuous rushing sounds and a watery discharge from the ear. Politzer's air-douche employed without, and the catheter with, result. From this time I lost sight of the patient.

This case is noteworthy on several accounts. It is particularly remarkable that, notwithstanding the repeated return of the serous exudation in the tympanum, an appearance of the memb. tymp. characteristic of this lesion was only once observed,—an earth-colored appearance of the membrane,—but without the presence of a line of demarcation. This was due at first to the serous infiltration of both tympanic membranes, and later to the changes induced in the right memb. tymp. by the previous inflammation.

The marked difference in the permeability of the Eustachian tubes, and in the resistance to the entrance of air on both sides, is of interest.

On the right side it was always more decided than on the left, and, as the history shows, returned in so great a degree that Politzer's air-douche was often ineffectual—once even when it was employed in connection with catheterization, and again when administered immediately after paracentesis.

The cause of the frequent relapses is plainly traceable to the repeated closure of the Eustachian tubes.

In performing paracentesis in a like case it would be more to the purpose and more advantageous to treatment to operate first upon the side offering the greatest resistance in such case. Politzer's air-douche might succeed better than when paracentesis on the opposite side had decreased resistance in the middle ear by the presence of an artificial perforation, as the air, on being forced in, would tend naturally to the side offering the least resistance. With so great a degree of resistance in the right tympanum it is remarkable that no fluid was ejected by the air-douche after paracentesis on this side. At first I believed that I had made a mistake in the diagnosis. The reactionary inflammation appearing upon the right side is traceable in part to the operation, but in a greater degree to the irregular and unhealthy mode of life resulting from the patient's occupation.

In answer to a written inquiry, I learned that the patient had omitted treatment on account of duty; that the recovery on the left side was perfect, but that he intended to consult me again on account of the right ear; but up to this time he has not done so.

CASE VII.—*Rapid accumulation of serum in both tympanic cavities. Paracentesis on both sides. Sudden restoration of hearing.*

Christoph Ludwig Weimar, 23 years old, tailor, from Wertheim. Three weeks ago he first noticed a dull feel-

ing in the head, difficulty in swallowing, and increased secretion of mucus in the throat, with rapid diminution of hearing on both sides; at the same time the patient had a continued sensation of sound in the head, compared to the rushing of steam from a boiler. The trouble developed without pain. In the morning the hearing was better than during the remainder of the day.

Examination.—Both tonsils much enlarged. Catarrh of the pharynx and nasal passages. Great resistance to the injection of air. Direct catheterization gave a regular bubbling râle. Both external ears normal. Both tympanic membranes of a chocolate color, the manubrium white, the membrane rather flat, the centre somewhat darker than the periphery, and without a light spot. But slight perception of sounds conducted through the bones of the head. The watch was heard at a distance of 1½ inch, and after the air-douche at 18 inches.

No line of demarcation observable either before or after the air-douche.

Paracentesis in the post. inf. segment on both sides, followed by the air-douche, liberated a great deal of greenish-yellow serum, which did not mix readily with the water when the ears were syringed, and remained sticking in the incisura intertragica. Perception of sound through the bones of the head is much increased. The watch is heard on both sides at a distance of 15 ft. Memb. tymp. now of a dull gray color, with a light spot on the right but none on the left side. Manubrial plexus in both ears is injected.

The next morning at 8 o'clock.—Operation not followed by the slightest reaction, the night passed well and without pain, and the subjective noises did not return. The hearing not quite so good as immediately after the operation. Both external passages dry. The memb. tymp. appeared the same as after the operation, and the presence of an artificial opening was only perceived on auscultation.

On the repetition of the air-douche a rather large quantity of greenish-red serum was seen in both ears, more in the right than the left, so much indeed that the niche formed by the membrane and the inferior wall of the meatus was filled full, and the lower half of the membrane hidden by the serum. The hearing distance, as tested with a common watch (of 6 ft. hearing distance), reached 4 ft.

An examination with the rhinoscope revealed excessive catarrh of the naso-pharyngeal cavity. It was necessary, in order to obtain a clear view, to cleanse it with the douche, which showed the condition commonly found in fresh catarrh of this region, and implication of the ostium pharyngeum tubæ (yellowish-green secretion at the entrance on both sides).

Notwithstanding the use of the nasal douche, a great deal of mucus still remained in Rosenmüller's fossa. I have already spoken of the condition of the tonsils. The patient did not again present himself for examination.

This case is marked by the development of a great degree of deafness in a very short time.

This was evidently caused in part by the closure of the Eustachian tubes, and in part by the quantity of the exudation, sufficient to fill even the upper part of the tympanum; the latter circumstance accounts for the absence of a line of demarcation. The coloring of the tympanic membranes was not bottle-green, but rather resembling chocolate.

The position was inconsiderably changed, and the great quantity of exudation would undoubtedly account for the absence of the characteristic appearance of the membrana tympani, notwithstanding the closure of the Eustachian tubes.

The fact that the hearing was better in the morning is probably due to the position on the back during the night, allowing the serum to flow away from the structures important to the transmission of sound (the ossicles and the fenestra), so that there was less obstruction during the first hours of the morning.

I should not consider the patient safe from relapse, as he abandoned further treatment.

EPICRITIC REMARKS UPON THE ABOVE CASES.

With exception of a boy 9 years of age, all the subjects were adult males.

The conjectural duration of the disease extended from 4 days to 3 weeks.

The immediate cause could be determined in one case only—a draught of air upon the head when perspiring.

In the remaining cases the affection must be considered a secondary one, an extension of the catarrhal inflammation from the nares and pharynx to the Eustachian tube. The degree in which inflammation and adhesion of the walls of the tube may influence a serous exudation into the tympanum has been clearly demonstrated by Politzer (l. c.), who says that the adhesion not only prevents the discharge of the secretions of the tympanum, but results in rarefaction of the air, and consequent decreased pressure upon the blood-vessels, which are frequently in a state of congestion from the extension of the irritation to the tympanic walls.

Continuous subjective noises were present in 4 cases; interrupted subjective noises in 2 cases,—in one so severe that the continued singing had a disturbing effect upon the mental action of the patient. In the majority of the cases these noises were removed by the introductory treatment; in one case they disappeared entirely only after a long course of treatment following paracentesis; in another case they persisted, and made an unfavorable symptom for the prognosis. Where they had once existed and been dispelled by treatment they returned on the occurrence of a relapse, and remained, as a rule, during its whole course.

In those cases where all signs of congestion were absent, the subjective noises could be taken as conclusive evidence of existing pressure, and where they persisted after paracentesis, as symptomatic of serious changes in the tympanum.

Vertigo was present in two cases; in one of these it continued after paracentesis had been performed, and was probably due to gastric trouble (see Case II.). In all those cases which ran their course independently, that is to say, without inflammatory complications, there was freedom from pain. In six of the cases, aside from complications, the external ear was free. In No. IV. only, which was a fresh case, the inner end of the meatus was congested, and the injection of the upper wall continued into the manubrial plexus; the latter alone was congested in one other case. The position, inclination, and curve of the tympanic membrane was unchanged in but two cases. As a rule, its concavity was very much increased, the manubrium drawn inwards or horizontally, in one case exceedingly light in color; the periphery was furrowed, etc. The causes of these varying appearances may be sought for, in part, in the different character of the illumination employed for the examinations, and in part in the varying color and consistency of the fluid itself. The color was not always bottle-green, but sometimes chocolate, bluish black, grayish green, or earthy. Where the mucous coat was either wholly or partially opaque, in consequence of the long participation of the tympanum in the catarrhal process, the characteristic coloring was either entirely or partly wanting in the anterior half of the membrane, as for example in Case V.

In Case VI. the symptomatic coloring was absent on both sides, in consequence of serous infiltration of the tympanic membranes. In one case the light spot was

wanting on both sides, but reappeared normally on one side after the paracentesis, and in one case it was multiplied. As a rule, it corresponded in appearance to the increased concavity of the membrane. But three cases were discharged with the memb. tymp. in normal condition. The "demarcation line" was absent in all the cases, relapses included, with the exception of two. In the majority this was caused by the large quantity of the serous secretion, as it was generally seen after paracentesis when the transparency of the membrane allowed.

The fact that air-bubbles were never observed in the fluid after the air-douche, was probably due to the resistance in the Eustachian tube and the quantity of the fluid, the air entering with difficulty, and where it did gain admission to the tympanum, the condition of the memb. tymp. was unfavorable to a view, on account of its loss of transparency. We have already spoken of the great resistance to injection of air through the Eustachian tube in several of the cases—Case VI. especially—and in one other where it prevented the ejection of the serum through the perforation in the membrane.

The sounds on auscultation corresponded to this condition; there was either a low creaking sound, imperceptible to the patient, during the whole of the air-douche, or a regular bubbling, rattling râle in the tympanum at the close, when the resistance had been overcome, or at the commencement, when it was not too great.

The conduction of sound through the bones of the

head was perfectly normal in Cases I., III., IV., and VI., some of them being affected on both sides. It was absent in Case II., diminished on both sides in Case VII., and varied in Case V., a common watch being heard on the right side, while only the test watch was perceived on the left. In all cases where it was diminished, or entirely absent, it returned in a normal degree after treatment.

The hearing power was much decreased in all the cases, and the great fluctuations which Politzer considers characteristic when a decided decrease commences in the pauses of treatment, were particularly noticeable in Cases I., II., and V. Increase of hearing on awakening in the morning distinguished Case VII. only.

Resonance of the voice was not observed by any of the patients, even in those where the affection was limited to one side, nor were any statements made from which the conclusion could be drawn that there was a sensation of movement in the middle ear. It seems to me that this symptom is more probable in those cases where the quantity of fluid collected is not so great.

These subjective phenomena may be characteristic in many cases. I do not consider them as pathognomonic, however, even when accompanied by a coëtaneous increase of the hearing power and resonance of the voice, referring especially to the observations made in the following case. It is given as I observed it, though it ends in an enigma.

Catarrh of the Eustachian tube on both sides. Sensation of the movement of a fluid in the ear accompanied

by improvement in hearing. Sensation of resonance. Paracentesis performed with negative result.

M., 60 years old, merchant, has suffered for eight months from pain in the temple and forehead, especially over the left orbit, and accompanied by a feeling of pressure in the left eye,—the latter, however, only exceptionally present. From time to time these pains increased, extending to the right side of the head (there were no spots of tenderness). Latterly a sensation of stoppage in the nose and in both ears has been added to the other discomforts. (Bromide of potassium, quinine, iron, and the whey-cure gave no relief.)

"If I recline my head," said the patient, "I feel a movement in the ears, especially in the left one, and the ears are suddenly freed from the stoppage; the longer my head rests the more free it is. When I awake in the morning my ears are perfectly free and the hearing good; but so soon as I raise my head erect the left ear fills itself, and shortly afterwards the right also, and I hear much worse. The head is never entirely free from pain, not even after long remaining in a horizontal position." The patient denied ever having had pain in the ears, discharge, subjective noises, or vertigo.

The examination showed both external ears normal. Both tympanic membranes were slightly opaque; beyond this, either in respect to position or hyperæmia, etc., there was no noticeable abnormality. These appearances remained unchanged when the patient bent his head forward. He made the same statement with regard to the

sensation as before, but neither a line of demarcation nor other noticeable change appeared. The hearing distance with the watch was 1½ inch on the right side, and 1 inch on the left.

The voice in the common tone of conversation was heard at a distance of from 8 to 10 paces. The watch was heard through the bones of the head on both sides, but the examination with the tuning-fork was negative in its results. On the patient being caused to place himself in the position above described, a gradual increase in the hearing power could be determined with the tests instituted for the purpose. It increased in proportion as the head was inclined forwards; on the right side it became 4 ft. for the watch, and 18 paces with the voice in a whisper, whereas on the left side it reached the normal standard—30 ft. for the watch.

The head being returned to an erect position, in a few minutes the same diminution in the hearing power appeared as before the experiment. The remarks with which the patient accompanied the movements of the head were curious. With the head inclined forwards, "Now the ear is empty." When in an upright position, "Now it is filling again."

On using Politzer's air-douche he experienced no sensation, neither could I determine any important increase in hearing power thereafter. I now essayed catheterization, and ausculted at the same time. There was a marked difference between the two sides; this difference was also noticed by the patient. Scarcely any air entered on

the right side, and the resulting râle resembled a faint creaking; the patient had no sensation from it in the middle ear, and the hearing power was not increased. On the left side, on the contrary, I heard, as if it were in my own ear, a loud blowing sound, readily perceived by the patient, and unaccompanied by bubbling râles. There was an immediate increase in the hearing distance of from 3 to 4 inches. After the operation there was injection of the manubrial plexus on both sides, but otherwise no perceivable change.

By the time of his departure the hearing was the same as before the examination. There was no change in the condition of the head, nor in the resonance of his voice; this latter symptom I had forgotten to mention. He described it very characteristically in the words, "It often seems to me, when I speak, as if I had an echo on the left side of my head."

When the patient presented himself four days later the condition of things was very nearly the same. Hearing distance (measured with the test watch of 30 ft., normal distance), right ear 12 inches, left ear 16 inches.

Politzer's air-douche was employed, the head being inclined forwards, but without change. On catheterization the hearing distance increased to 21 inches in the right ear, and 24 inches in the left. I made an examination with the rhinoscope, but could perceive nothing more than a catarrh of the pharynx. The pharyngeal openings of both Eustachian tubes were small, but beyond this nothing remarkable was observed.

The patient perceived no cracking sounds accompanying the movements of the head, swallowing, etc.

He repeated the former experiment with the same results on both sides, and I again convinced myself, by testing the hearing power in the left ear, with the voice in a whisper, that after the patient had made the movement of the head above described his perception for this test was most excellent, while before that a loud voice was heard at no greater distance than 18 paces.

There was no question of dissimulation, the less so that the patient, accompanied by his brother, made a pretty long journey every time that he visited me. Moreover, nothing has as yet been said concerning a legal process with which the case was incidentally connected.

Although I doubted the presence of a movable exudation in the middle ear, certain symptoms induced me to perform paracentesis on both sides. These were: the sensation as of movement of a fluid in the ears, accompanied by marked improvement in hearing; and the sensation of resonance, particularly on the left side.

I performed paracentesis and injected air, which passed through the openings on both sides with a hissing noise, and without the appearance of a trace of fluid, although the air-douche was used several times, and repeated a few hours later. The hearing power remained the same as before the paracentesis.

No reaction followed the operation, and the patient's condition remained in every respect the same, so that on

his departure, after a further period of four days devoted to the treatment of the pharynx, nasal passages, and Eustachian tube, we were both much dissatisfied.

The peculiarity of the case is to me inexplicable; but I nevertheless considered it my duty to report it.

In answering the question, what certain signs have we, in cases of diminished transparency of the memb. tymp. by which to establish a diagnosis of the presence of serous accumulations in the tympanum, we must admit that, under the circumstances above described, it can only be a diagnosis of probabilities, and it would be well to retain the patient under observation a few days before determining upon paracentesis; because, though it may be performed in the majority of cases without detriment, in a few of our cases we saw unfortunate consequences which we could not but trace directly to the operation. In three cases it was followed by painful purulent inflammation, which resulted in the formation of furuncles in the external meatus. Whether the rigors occurring on the first and second evenings after the paracentesis in Case II., were directly referable to the operation, is questionable. Great resistance in the Eustachian tube, and the regular bubbling râles which occur where a lesser degree of resistance permits the passage of the air, together with the immediate improvement in hearing and its subsequent decrease when the air-douche is not continued, may be taken as the most reliable guides to the diagnosis when it cannot be con-

clusively determined by the examination of the membrana tympani.

Treatment.—It may perhaps appear strange that I determined upon paracentesis in each of the seven cases, even when both sides were affected. The object was to see if it were not possible to shorten the period of treatment. Aside from the fact that this is desirable to the surgeon in all cases, it is especially to be considered when the patient comes from a distance, often of many miles. In such case a short term of treatment is particularly acceptable.

The results of these cases cannot be taken for comparison, especially when we consider the complications described in connection with them, with the exception, perhaps, of two (Cases II. and V.). In the remainder we can scarcely lay the blame either to the unfavorable circumstances by which some of the patients were surrounded, or to the prevailing cold wet weather of this summer at the time of treatment. In the chronic cases the obstinacy of the affection and the frequency of relapse were due to the long existing closure of the Eustachian tube, which often persisted during the first part of the treatment, and tended to induce a rapid reproduction of the serum—(compare Case VI.).

This occurred in Case II. (after a lapse of sixteen hours, the Eustachian tube being free, and the artificial perforation remaining open), notwithstanding the permeability of the tube, because, as a result of the persistent duration of the trouble, the congested vessels of the tym-

panum continued to retain their tendency to serous exudation for a long time. This fact indicates immediate paracentesis in recent cases. In chronic cases I should attempt in the first place to attain the desired end by use of Politzer's air-douche, with the head reclining or bent far forward.

Further concerning Politzer's air-douche. Case VI. shows that it is sometimes ineffectual (even after paracentesis), on account of the resistance in the Eustachian tube. I should perform paracentesis in chronic cases where treatment with the air-douche had been continued for some time without the desired effect. It is unconditionally indicated where the air-douche has been entirely ineffectual, because of the excessive quantity of the secretion and resistance in the Eustachian tube.

In cases when both sides are affected, it should be first performed on the one where there is the most resistance.

During the time immediately following the paracentesis we should not omit to make the patient remain in bed, or keep to his room, at least until the perforation has closed, and in unfavorable weather under all circumstances. Early treatment of the pharynx and nasal passages is necessary.

On the whole, the results are so favorable and the cure so often a permanent one, that the treatment of serous accumulations in the tympanum may be numbered among the most satisfactory in aural surgery.

ON THE MECHANISM OF THE OSSICLES OF THE EAR.

By ALBERT H. BUCK, M.D., OF NEW YORK.*

IN 1851 Edward Weber † put forth the doctrine that in the transmission of sound from the external ear to the acoustic nerve the ossicles play the part of a solid angular lever, whose office is to transmit to the fluid of the labyrinth the movements imparted to the *membrana tympani* by waves of sound. According to this doctrine the fluid of the labyrinth is moved only as a whole, and the function of the *membrana tympani secundaria* is simply that of affording a point where the fluid can yield to the pressure made upon it by the base of the Stirrup.

On the other hand, the prevailing doctrine was that the ossicles form a connecting medium through which waves of rarefaction and condensation are transmitted from the *membrana tympani* to the fluid of the labyrinth, and that some waves of sound also reach the labyrinth by way of the *fenestra rotunda.*

* An essay to which a prize was awarded by the Alumni Association of the College of Physicians and Surgeons of New York.

† Berichte über die Verhandlungen der K. Sächs. Gesellschaft der Wissenschaften zu Leipzig. Math. Phys. Classe, 1851.

Between these two views physiologists have been divided in opinion even up to the present time, although the majority perhaps favor the former doctrine.

In the following experiments an attempt has been made to determine by direct observation which view is the correct one. The method employed in the investigation is very simple, and free from the objections to which Politzer's method is liable.* This experimenter attached fine glass rods to different parts of the ossicles and studied their action whilst concentrated waves of sound were being conducted into the external auditory canal. As will be seen farther on, these rods constitute an important disturbing element, both by their weight and elasticity.

I am indebted to Prof. Helmholtz as well for the suggestion of this method, as for his constant assistance throughout the course of the experiments.

Material used, mode of preparing it for observation, and means employed for conducting waves of sound into the external auditory canal.

Specimen.	Age.	Sex.
Nos. 1 and 2.	30.	Male.
No. 3.	20.	Female.
Nos. 4 and 5.	50.	Male.
No. 6.	40.	Male.
No. 7.	20.	Male.
Nos. 8 and 9.	29.	Male.
Nos. 10 and 11.	29.	Male.

In the following experiments eleven human adult temporal bones were used. They were removed from the

* Archiv für Ohrenheilkunde, 1864.

bodies as soon as possible after death, and preserved in a very weak solution of spiritus vini.

A portion of the cartilaginous external auditory canal was left attached to each temporal bone, sufficient to admit of the introduction of a suitable sound-conducting tube. The roof of the drum was then carefully chiselled away until a good view could be obtained of the greater part of the hammer and anvil, and of the head of the stirrup. The labyrinth and all the connections of the membrane of the drum and ossicles, with the exception of the *ligamentum mallei superius*, were left undisturbed. As a sound-producing medium, organ-pipes were found to answer the purpose best. To connect these with the ear in such a way that the vibrations within the pipe might be conveyed with the least possible loss to the air contained in the external auditory canal, the open end of the pipe was closed with a thin board cover, and a glass tube 17 cm. long, and with a lumen of 14 mm., was firmly inserted into an opening in the centre of the board. The free end of the glass tube had been previously drawn out so as to present a lumen of 5 mm. This was made to fit tightly in the external ear by surrounding the end with sealing-wax. For light an ordinary kerosene lamp was used, the rays from which were concentrated by means of a convex lens on the spot to be observed. This had been previously dried with the end of a heated wire, and then sprinkled with powdered starch. These fine masses of starch, when examined with a low power of the microscope (24 diam.), appear-

ed as sharply defined luminous points, or, when set in rapid motion, as luminous lines. In the course of the experiments, however, it was ascertained that starch could be dispensed with, as the simple irregularity and moisture of the parts offered a sufficient number of luminous points for all purposes of observation.

Lengths of excursions on different parts of the ossicles.

The following measurements were made by means of an ocular micrometer. By turning the eye-piece round until the luminous lines ran exactly at right angles to the subdivisions of the micrometer, their lengths could then be readily measured. As far as possible they were taken from the same positions, namely, from above, as seen in Fig. 1, and from the side, as seen in Fig. 2.

With an organ-pipe of 110 *vibrations.*

Number of Specimen.	Head of Hammer from above.	Body of Anvil from above.	Head of Stirrup from above.	Head of Stirrup from side.
1	0.07 mm.	0.04 mm.	0.03 mm.	Not observed.
2	0.09 mm.	0.04 mm.	Scarcely visible.	" "
3	0.03 mm.	0.03 mm.	0.03 mm.	" "
5	0.04 mm.	0.03 mm.	Scarcely visible.	Scarcely visible.
6	0.04 mm.	0.03 mm.	" "	" "
Average =	0.05 mm.	0.03 mm.	0.01 mm.	

With an organ-pipe of 220 *vibrations.*

Number of Specimen.	Head of Hammer from above.	Body of Anvil from above.	Head of Stirrup from above.	Head of Stirrup from side.
1	0.28 mm.	0.14 mm.	0.03 mm.	Not observed.
2	0.28 mm.	0.16 mm.	0.06 mm.	0.06 mm.

3	0.12 mm.	0.07 mm.	0.03 mm.	0.04 mm.
4	0.12 mm.	0.06 mm.	0.03 mm.	0.03 mm.
5	0.06 mm.	0.03 mm.	Scarcely visible.	Scarcely visible.
6	0.09 mm.	0.05 mm.	" "	0.03 mm.
7	0.24 mm.	0.12 mm.	0.03 mm.	Not observed.
Average =	0.17 mm.	0.09 mm.	0.025 mm.	0.03 mm.

With an organ-pipe of 400 *vibrations.*

Number of Specimen.	Head of Hammer from above.	Body of Anvil from above.	Head of Stirrup from above.	Head of Stirrup from side.
1	0.28 mm.	0.12 mm.	0.06 mm.	Not observed.
2	0.21 mm.	0.12 mm.	0.06 mm.	" "
3	0.21 mm.	0.12 mm.	0.06 mm.	0.07 mm.
4	0.19 mm.	0.09 mm.	0.03 mm.	0.04 mm.
6	0.21 mm.	0.09 mm.	0.03 mm.	0.03 mm.
7	0.21 mm.	0.12 mm.	0.04 mm.	0.04 mm.
8	0.09 mm.	0.06 mm.	0.04 mm.	Not observed.
9	0.31 mm.	0.24 mm.	0.12 mm.	0.31 mm.
10	0.31 mm.	0.16 mm.	0.03 mm.	Not observed.
11	0.31 mm.	0.16 mm.	0.01 mm.	" "
Average =	0.23 mm.	0.128 mm.	*0.048 mm.	0.09 mm.

With an organ-pipe of 600 *vibrations.*

Number of Specimen.	Head of Hammer from above.	Body of Anvil from above.	Head of Stirrup from above.	Head of Stirrup from side.
1	0.09 mm.	0.04 mm.	0.01 mm.	Not observed.
2	0.07 mm.	0.04 mm.	0.01 mm.	" "
3	0.07 mm.	0.04 mm.	0.03 mm.	" "
4	0.06 mm.	0.03 mm.	Scarcely visible.	" "
Average =	0.07 mm.	0.037 mm.	0.012 mm.	

* By compressing the air in the external auditory canal and measuring the isplacement in a column of mercury connected with the superior semi-circular anal, Helmholtz estimated the length of an excursion of the base of the stirup at 0.05 + mm.—*Mech. der Gehörknöchelchen, etc.*, 1869.)

Direction of luminous lines on different parts of the ossicles.

As observed from above, the luminous lines on the heads of the hammer and anvil appeared slightly divergent outwards (see Fig. 1). This divergence was found to be the same on all the specimens. As observed from the side, in a direction at right angles to the long axis of the hammer, they presented the following appearance:—On the hammer the luminous lines appeared to be arcs of circles whose common centre lay in the immediate neighborhood of the *Processus Folianus* (see Fig. 2). On two of the specimens it was noticed that the luminous lines, measured at the very end of the handle of the hammer, were 0.43 mm. and 0.38 mm., whilst those measured at the head were 0.31 mm.; in other words, that in these instances, at least, the axis of rotation did not pass through the middle of the ossicle, but somewhat above it. On the anvil the luminous lines followed the direction marked in Fig. 2. On the lower part of the long process they seemed to be nearly or quite vertical, but on approaching the body of the bone they became more oblique. Owing to the enclosed position of the anvil, it was not found practicable to obtain an observation from the side higher up than the one marked in Fig. 2. On four specimens the relative measurements

Fig. 1.

on the body (seen from above) and the long process (seen from the side) of the anvil were as follows:—

Number of Specimen.	Body.	Long Process.
8	*2	1½
9	8	10
10	5	2
11	5	8

They are of interest, as helping to indicate the position of the axis of rotation of this ossicle. In specimens No. 8, No. 10, and No. 11, the hammer and anvil were joined together in the ordinary manner as represented in Fig. 3, whilst in specimen No. 9 the anvil was more inclined inwards (see Fig. 4). In Fig. 3 (drawn from specimen No. 10) the luminous lines are arcs of circles whose common centre is at A. The top of the body of the anvil being twice as far from this centre as the end of its long process, its excursion is twice as great In Fig. 4 (drawn from specimen No. 9) the different lengths of excursion can only be explained by supposing the axis of rotation to be placed nearer

Fig. 2.

the body of the ossicle (as at A′). As observed from

* Number of micrometer subdivisions.

above, the luminous lines on the stirrup appeared in the majority of cases to be directed nearly, though not quite, at right angles to its base. In only two cases was it found possible to obtain a view of both arms of the stirrup at once. In one of these cases the luminous lines were directed at right angles to the base (see Fig. 5), while in the other they ran somewhat obliquely toward it. The inclination in all cases was toward the anterior extremity of the base (see Fig. 6).

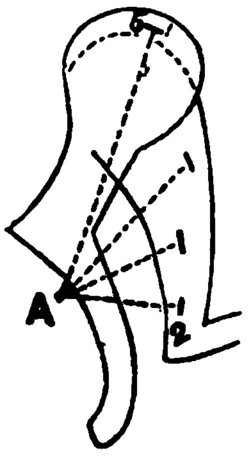


FIG. 3.

Viewed from the side, the luminous lines on the stirrup were in all instances directed obliquely upwards and inwards across the head and anterior arm (see Fig. 2).

In spec. No. 6 the upper and inner wall of the vestibule was carefully chiselled away, so as to present an inner view of the base of the stirrup. When it was put in vibration the luminous lines on the upper border of the base measured 0.03 mm., and were vertical, but on the lower border there was not sufficient motion to admit of measurement.

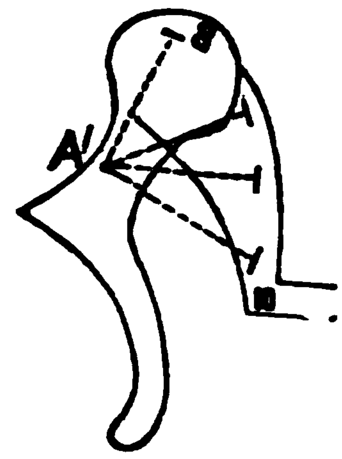


FIG. 4.

Fenestra Rotunda.

Enough of the lower wall of the drum was removed in specimen No. 1 to admit of a good view of the *membrana tympani secundaria.* The moment the organ-pipe was sounded the bright spot in the centre of the mem-

brane lengthened out into a distinct luminous line of 0.04 mm. On the head of the stirrup, as seen from above, the luminous lines measured only 0.03 mm. The superficial area of the *fenestra rotunda* being smaller than that of the base of the stirrup, a greater excursion might rightly be expected from the membrane of the former. In the present case the membrane was observed

FIG. 5.

obliquely from the side and not directly in profile, so to speak; hence the measurement would represent only a portion of the true length of the excursion. The measurements on different parts of the ossicles, before and after breaking up the membrane, were the same.

The influence of the different ligaments.

Tendons of the *tensor tympani* and *stapedius*. The measurements immediately before and after the division of these tendons (considered as ligaments) were precisely the same, and no difference could be observed in the direction of the luminous lines on the stirrup after the division of the tendon of the *stapedius*.

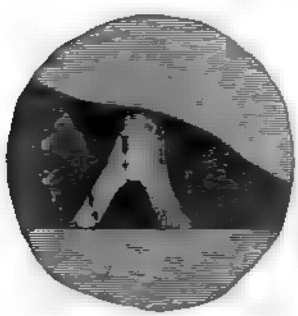


FIG. 6.

The modifications produced by attaching fine glass rods to the hammer and anvil.

A fine glass rod, of about the thickness of a fine bristle, and 5 cm. long, was glued in an upright position to the head of the hammer. Before doing this the measurements with an organ-pipe of 400 vibrations were:

Head of hammer = 0.31 mm.
Body of anvil = 0.16 mm.

Afterwards they were found to be:

Head of hammer = 0.12 mm.
Body of anvil = 0.06 mm.

Cutting off 1 cm. from the end of the rod, the measurements were:

Head of hammer = 0.16 mm.
Body of anvil = 0.09 mm.

Cutting off 2 cm. they were:

Head of hammer = 0.16 mm.
Body of anvil = 0.09 mm.

Cutting off 3 cm. they were:

Head of hammer = 0.18 mm.
Body of anvil = 0.10 mm.

Cutting off 4 cm. the measurements remained the same. Leaving nothing but the small drop of glue, the measurements were:

Head of hammer = 0.24 mm.
Body of anvil = 0.12 mm.

After removing the glue from the head of the hammer and fastening a glass rod 5 cm. long and of the same thickness as the preceding to the body of the anvil,

the measurements with an organ-pipe of 400 vibrations were:

Head of hammer = 0.31 mm.
Body of anvil = 0.12 mm.

Cutting off 1 cm. they were:

Head of hammer = 0.31 mm.
Body of anvil = 0.13 mm.

Cutting off 2 cm. the measurements remained the same.
Cutting off 3 cm. they were:

Head of hammer = 0.31 mm.
Body of anvil = 0.16 mm.

These experiments would show that the method of using glass rods to determine the character of the vibrations of the ossicles is not trustworthy. Even a drop of glue, the size of a pin's head, attached to the head of the hammer was sufficient to reduce its excursion 0.07 mm. On the anvil the disturbing influence of a weight or rod was much less than on the hammer.

Anatomical study of the manner of attachment of the Stirrup to the Fenestra Ovalis.

After having determined the direction in which the stirrup vibrates, the question presented itself, whether its base were not attached to the *fenestra ovalis* in a manner specially adapted to this mode of vibration. Works on anatomy give such meagre and conflicting information on this point that it was thought necessary to investigate it more thoroughly. The method employed

was suggested by Prof. Julius Arnold, under whose kind supervision the investigation was made.

The stirrup, together with the mass of bone immediately surrounding it, was first removed from the temporal bones of new-born children and adults as soon as possible after death, and in such a manner as to obtain this ossicle with all its attachments to the *fenestra ovalis* uninjured. These specimens were placed in three ounces of a 1% solution of chromic acid, the solution being renewed every fourth day after. At the end of a month a 2% solution was used. Two weeks later, two of the specimens were soft enough to be cut with the razor. The others remained a week longer in a 2% solution, to which three drops of concentrated hydrochloric acid had been added. From these solutions of chromic acid the specimens were transferred to alcohol, and, when sufficiently hardened, they were imbedded in paraffine. Fine sections were now made with the razor in both horizontal and vertical directions. In order to make the sections exactly parallel with the two axes of the base (the long or nearly horizontal, and the short or nearly vertical) the paraffine was carefully removed from the vestibular side of the stirrup, so as to expose only its base to view, whilst all the rest of the bone remained firmly imbedded in it. As some of the horizontal sections included the *musculus stapedius*, the anterior and posterior parts were easily determined. In the vertical sections the presence of the *tensor tympani* afforded the same assistance in locating the upper and lower parts.

In the study of these horizontal and vertical sections the base of the stirrup is found to be attached to the *fenestra ovalis* by a circular band of uniform strength throughout. Its fibres run in a convergent direction from the margin of the *fenestra* to the opposite margin of the base of the stirrup. In their course they cross each other at very acute angles. They are rich in oval nuclei, and are separated only by a slight quantity of an homogeneous, but dense intercellular substance. The periosteal covering of the bone in the immediate neighborhood of the *fenestra ovalis* is continuous with this circular band, or, in other words, the tympanic and vestibular layers of periosteum unite at the margin of the *fenestra*, then run together as one band as far as to the margin of the base of the stirrup, where they subdivide to take the base between their folds, and serve it in the capacity of periosteal covering.

On the outer side the band is covered everywhere with the mucous membrane of the drum, which was found here to be rich in blood-vessels of various sizes. In many of the horizontal and vertical sections, cross-sections were found of large arteries at the very edge of the *fenestra*, or even directly in front of the band. These sent off smaller branches that pierced the band in various directions.

On the inner side the band is also covered with an epithelial layer, which is, however, much thinner than the outer one.

In adults the bone forming the *fenestra ovalis* differs

in nowise from ordinary bony tissue, except that at the periphery, immediately beneath the periosteum, there is always found a thin layer of cartilage-like tissue, consisting of ovoidal and spindle-shaped cells and an homogeneous intercellular substance (periosteal cartilage). The same tissue is also found at the periphery of the bone in children, and moreover, in the very substance of the bone small cartilaginous islands are often seen.

The base of the stirrup is likewise formed of true bone, at the periphery of which there is found a thin layer of periosteal cartilage immediately beneath the periosteum, and intimately united with it. In adults the base was found to be thicker at the two ends than in the centre; the two ends were, however, very nearly alike in thickness. In children the posterior end was found to be thick and quadrangular, whilst the anterior was narrow and rounded (see accompanying plate). The layer of cartilage beneath the vestibular periosteum was found, moreover, to be much thicker than in the adult.

It is necessary to state here that unless the sections are either parallel or at right angles to the long axis of the base, they will totally misrepresent the true relations of the parts. For instance, among a number of vertical sections cut from the same specimen, I obtained three entirely different views: one where the lower border appeared somewhat flattened, whilst the upper was smaller and more pointed; a second, where the reverse was found to be the case; and a third, where both ends appeared alike. The breadth of the circular band varied

also, according to the direction in which the section was made.

To state briefly the results of this anatomical study: (1) The stirrup is attached to the *fenestra ovalis* by means of a circular band composed of elastic tissue; (2) The fibres of this band run from the margin of the *fenestra* to the base of the stirrup in a convergent direction; (3) The band is formed of the layers of periosteum covering the bone in the immediate neighborhood of the fenestra, and on reaching the base of the stirrup it again resumes its function of periosteum; (4) The band is everywhere of equal breadth.

From the preceding experiments two conclusions are arrived at: (1) That the bones of the ear vibrate as a whole; and (2) That with each vibration there is a corresponding displacement of the fluid of the labyrinth.* This is precisely the doctrine held by Weber twenty years ago. It also appeared that with each wave of sound the membrane of the drum is driven inwards a certain distance and then returns to its original position, so that the end of the handle of the hammer, which is imbedded in the substance of the membrane of the

* Politzer first proved experimentally that the ossicles vibrate as a whole (Archiv für Ohrenheilkunde, 1864). The chief question of dispute had been concerning the movement of the fluid of the labyrinth as a whole. Politzer and Helmholtz sided with Weber, whilst Henke and Schmiedekam held the contrary view.

drum, makes an excursion to and fro of equal length, and the length of such an excursion may amount to 0.43 mm. without any appreciable injury to the parts. But if one places the glass tube of the organ-pipe in his own ear the shock produced on the membrane of the drum is felt to be too painful to be borne for any length of time, so that the ordinary excursion of the membrane of the drum during life would seem to be much less than this measurement. The axis of rotation of the hammer lies nearly midway between its two extremities, so that when the end of the handle is driven inwards the head makes an equal excursion outwards. The particles forming the upper part of the head of the hammer move very nearly horizontally outwards, whilst those near the lower margin of the *malleo-incudal* joint move upwards as much as outwards. Helmholtz has shown that the hammer and anvil are united by a joint which in principle resembles that used in watch-keys, where the head of the key can be made to rotate in one direction without carrying the body with it, whilst in the opposite direction the body must necessarily follow. The lower tooth of the incudal half of the joint fits into a depression on the inner side of the hammer, just where the particles forming that part vibrate in an upward and outward direction. From an observation of the luminous lines on different parts of the anvil it was found that in fact such an upward and outward motion is communicated to this ossicle.

But in addition to this motion the body of the anvil

is thrown slightly backwards, or, in other words, the end of its long process is thrown forwards, as if the axis of rotation ran from the end of the shorter process of the anvil forwards, downwards, and outwards through the *processus brevis* of the hammer.

The head of the stirrup being joined to the end of the long process of the anvil by a fully formed capsular joint, it is obliged to follow to a great extent the direction taken by the end of the long process of the anvil, namely, upwards, slightly inwards, and forwards. As a result of this, the upper and anterior border of the base of the stirrup is driven farther into the vestibule than the lower and posterior border; * in other words, its axis of rotation runs either through the lower border of the margin of the *fenestra ovalis*, or a little below and parallel to it. Hence a displacement of the entire mass of the fluid of the labyrinth takes place, and in no other manner can the vibrations observed on the *membrana tympani secundaria* be explained.

The average measurements show that an impulse given to the centre of the drum is communicated from ossicle to ossicle with a loss in the following ratio:—

Hammer = 4
Anvil = 2
Stirrup = 1

In two cases (see first table of measurements) where the

* By a somewhat different method of investigation Helmholtz determined the axis of rotation of the stirrup. The above result confirms his description in its essential points.

membrane of the drum was caused to vibrate feebly, scarcely any loss took place in the transmission of the impulse from the hammer to the stirrup. Taking into consideration, moreover, that all these measurements may be looked upon as representing rather the maximal than the ordinary excursions of the ossicles, it may well be doubted whether during life the loss in transmission be not much smaller than that given above.

HISTORICAL AND CRITICAL REMARKS CONCERNING THE DEAFNESS FOLLOWING MENINGITIS CEREBRO-SPINALIS.

By S. MOOS, M.D.

Translated by Dr. Joseph Aub, of Cincinnati.

In Nro. 1 of the "Monatsschrift für Ohrenheilkunde," Voltolini, in a paper describing a new disease discovered by him, and titled "The acute inflammation of the membranous Labyrinth, commonly but erroneously considered as Meningitis," takes occasion to criticise the remarks made in my "Klinik der Ohrenkrankheiten," on the deafness occurring so frequently after meningitis. He believes that the thirteen cases observed by me were all primary acute inflammations of the labyrinth. Voltolini does not even acknowledge the possibility of their being secondary diseases of the labyrinth, occasioned by a propagation of the meningitis. The reasons which he alleges to corroborate his doubts on the correctness of my statements are the following, among others:—

The want of all paralytic symptoms, especially in the region supplied by the facial nerve, speaks against a meningitis with exudation at the auditory nerve. Vol-

tolini asserts that he has never noticed a trace of facial paralysis, and asks, "How is this possible when there is exudation in the auditory nerves? This is utterly inconceivable." He then sums up the anatomical reasons why this appears inconceivable to him.

Experience shows, however, that what may appear inconceivable to some is nevertheless possible, and of actual occurrence. Voltolini might easily have gathered some information on the subject in reading my discussion of the affection (p. 324, l. c.), had he only not omitted to peruse my quotations from *Niemeyer's* Monograph on epidemic cerebro-spinal meningitis, where the following is emphatically expressed:—

"Hardness of hearing, up to complete deafness, sometimes in one ear, sometimes in both, has been noticed in comparatively many cases. Occasionally it manifests itself early, at other times during the further progress of the affection, and may, when the primary disease is protracted, continue for weeks, and even for months, as I have shown in a case mentioned above. It may even outlast the primary disease in cases ending in recovery.

"I do not consider it improbable that the deafness and hardness of hearing may be produced by different causes. In the pathological specimen examined by myself in connection with Prof. *Luschka*, and which Dr. *Riedel* had the kindness to send me to Tübingen,—consisting of the pons, cerebellum, medulla oblongata, and portion of the spinal column of J. Schwarz,—we found the acoustic nerve, up to its exit from the skull, so completely em-

bedded in masses of exudation, that Prof. Luschka felt justified in supposing that the inflammation and exudation following the course of the nerves might easily, in some cases, extend into the labyrinth, and thus produce deafness. We could readily corroborate in the same specimen the fact that the exudation extended from the base of the brain, through the hiatus Magendii (described by Luschka, and lately denied and declared artificial by *Reichert*), into the fourth ventricle, and there principally covered the striæ acusticæ. Adding to this the fact that the immersion of the acoustic nerve in exudative masses alone may produce deafness, we cannot be astonished at the frequency of this symptom in the epidemic cerebro-spinal meningitis." This passage seems to have entirely escaped the attention of Voltolini.

Since then a number of facts have been published which demonstrate that deafness is not an accidental but a remarkably frequent symptom of, or an affection consequent on, cerebro-spinal meningitis. Refer:—

1. Report on those persons in the Bavarian army who received medical treatment during the first half of the year 1865; published in the Baierischen aerztlichen Intelligenzblatt, Nro. 52, 1865.

2. Dr. *Gustav Ohlsen.* Beitrag zur *Cerebrospinal-Meningitis.* Wuerzburg, 1866.

3. *Ziemssen* and *Hess.* Deutsch. Archiv fuer Klin. Med., I., 1, 3, 4. 1865.

4. Dr. Fluegel. Bayer. Intelligenz. Nro. 50. 1865. The epidemic cerebro-spinal meningitis in the district Naila.

Among about 300 cases, 5 remained deaf, 6 hard of hearing, 5 deaf-mutes, 1 deaf and blind, 3 deaf and unable to walk, and 1 blind in one eye. Total, 21 consequent diseases, or, as he calls it there, "meningitic cripples," were observed.

5. Dr. *Schweizzer*. The epidemic cerebro-spinal meningitis in the district Kronach during the year 1865. Wuerzburg, 1866. Among 115 cases during this epidemic, the most frequent sequelæ consisted in derangements of hearing, which were not only the result of a central cause, but also of a local disease of the middle ear *

6. Dr. *Orth*, on *Meningitis cerebro-spin. epid.* in the Rhein Palatinate, in the first half of the year 1865. (*Inaug. Dissertat.* Wuerzburg, 1866.) Deafness was observed twice, and strabismus three times, as among the sequelæ, in 53 cases.

7. Dr. *Bauer*. Report of 109 cases in the "Archiv des Vereins fuer Wissenschaftliche Heilkunde," III., 1, p. 173. Hallucinations of hearing were always present; complete deafness in 7 cases of recovery, and in 6 of death. Epidemic of Kentershausen and vicinity.

8. Monograph on epidemic cerebro-spinal meningitis by Prof. *Mannkopf*, M.D. Brunswick, 1866. Among 16 cases he observed, 4 presented disturbances of hearing.

9. *A. Heller*. The anatomical changes leading to dis-

* Such post-mortem observations, especially purulent inflammations of the middle ear, were first described by *Klebs*; we have mentioned them (l. c. p. 326).

turbances of hearing in *cerebro-spinal meningitis.* Deutsch. Archiv fuer Klin. Med., III., p. 482.

The two following observations relating to our subject are taken from a series of cases which occurred during a wide-spread epidemic:—

Case I.—Purulent cerebro-spinal meningitis. Fresh hemorrhagic, and numerous encephalitic foci in the brain. Croupous pneumonia of the left side, splenic tumor, diffused swelling of the kidneys. In both tympanic cavities much pus. In the vestibules numerous pus-cells, a larger quantity in the ampullæ; the cochleæ were very red, and filled with pus-cells. The vessels of the membranous portion of the lamina spiralis are much injected; its peripheral half is filled with pus, the inner half of its surface less so. *NN. acust.* and *facialis* of both sides surrounded by pus in the *meat. audit. int.* On microscopical examination very few pus-cells were found between the fibres of the facialis, whilst those of the acusticus and its ganglion cells are densely surrounded by them. In both nerves the fibres are well preserved, the vessels filled to bursting, and their walls thickened.

Case II.—Woman, aged forty-five. Disease of the brain and pneumonia. Post-mortem examination:—Purulent *meningitis cerebro-spinalis,* etc. The organs of hearing present about the same changes as the first case; in addition, dotted ecchymoses in the peripheral portion of the lamina spiralis.

We see therefore that purulent inflammations in the

inner ear and tympanic cavity may accompany the disease in question. We have to deal with a well marked inflammation of the labyrinth. This may occur simultaneously with the changes in the meninges of the brain and spinal column, or, following the course of the neurilemma, it may advance into the labyrinth.

Finally, I would add that the co-editor of these Archives assured me that during his stay in Heidelberg he observed about forty cases of diseases of the eye, mostly purulent choroiditis, consequent on cerebro-spinal meningitis.

Of all these cases only one, which I afterwards examined, suffered from deafness, and yet the report of the attending physicians and the examination of the patients showed that disease which, according to Voltolini, is not meningitis, but "independent acute inflammation of the membranous labyrinth." It would be carrying coals to Newcastle to enter into further discussion on this subject; I will therefore pass over the other arguments of Voltolini, which contain nothing new; for instance, that children with *otitis media purulenta* often manifest cerebral symptoms, or that a staggering gait, and even vomiting, are also met with in other ear diseases, etc., etc.; for I, as well as other physicians, have seen the disease not only in children (on which fact Voltolini lays great stress), but also in adults, and have indeed published (p. 327, l. c.) the precise history of the case of a girl of seventeen, in which the diagnosis was no more doubtful than in the case published in the first number

of these Archives. Nor have I declared the staggering gait as pathognomonic, but only mentioned it among the sequelæ of this disease.

In conclusion:—In view of the above clinical observations, and the pathologico-anatomical facts, no one will doubt the frequent occurrence of a nervous deafness which may accompany, or be the result of *meningitis cerebro-spinalis epidemica*, and I think that even Voltolini is now of the same opinion. We only hope that he may very soon succeed in proving by a post-mortem observation that the disease described by him as "the acute inflammation of the membranous labyrinth" is an independent affection.

SUDDEN HEMORRHAGE INTO THE RIGHT TYMPANUM ACCOMPANYING ANGINA DIPHTHERITICA—PROTRACTED RECOVERY.

By Prof. S. MOOS.

Translated by C. J. Blake, M.D., Boston.

The following case was observed in the daughter of a colleague by whom I was called in consultation, and to whom I am indebted for the history:—

Miss H. A., 17 years old, previously in perfect health, was attacked on the 9th of April, 1868, with general symptoms of fever, which increased on the following day, accompanied by the formation of diphtheritic deposits, first upon the left and then upon the right tonsil.

Within a few days the exudation extended over the tonsils, which were much enlarged, and implicated a portion of the uvula. The glands of the neck, especially upon the right side, where the tonsil was most affected, became swollen, and the movement of the lower jaw was rendered difficult and painful. Following the internal administration of kali chloric. and a mild gargle, the throat rapidly became clean, the fever and accompanying troubles diminished, and at the end of a week, dating from the time of the attack, the patient was free from fever, and remained so for several days.

On the night of the 21st and 22d of April, without any apparent

cause, the trouble returned, accompanied by active fever. The right tonsil became covered with new exudation, which in this case affected the inner surface more especially, and obviously extended backwards and upwards. It being impossible to introduce the rhinoscope, this fact was inferred from the increased difficulty in moving the jaw, the acute pains radiating outwards from the course of the Eustachian tube, and the impermeability of the right nostril. The hearing power on the right side was also diminished, and singing sounds in the ear occurred from time to time.

In addition to the superficial exudation there was a decided diphtheritic infiltration of the tonsils.

On the 23d of April, the urine, hitherto clear and secreted in small quantity, showed the presence of albumen,—at first nearly a third of the volume of the specimen examined. This decreased, however, on the exhibition of decoct. fruct. colocynth., so that on the 28th the urine was free from albumen and continued to be secreted in larger quantity. During this period frequent vomiting occurred, and the local as well as general troubles were very marked. The following is the daily record of the pulse and temperature (*Celsius*) for the above period:—

	TEMPERATURE.		PULSE.	
	A.M.	P.M.	A.M.	P.M.
April 24	39.0	39.1	96	104
" 25	39.2	39.6	97	108
" 26	38.4	38.9	96	112
" 27	37.9	38.5	84	92
" 28	37.8	37.9	80	84
" 29	37.0	37.2	72	77

From the commencement of the relapse ungt. hydr. cin. and cataplasms were freely used, and aq. calcis inhaled by means of the atomizer. For several days from the 29th of April the temperature and pulse remained about the same; the nasal tone of the voice and the difficulty in swallowing—due to the swollen condition of the affected parts—were but little diminished, although examination failed to detect the

presence of diphtheritic exudation. On the whole, considering the severe symptoms of the past few days, the condition of the patient gave promise of continued improvement.

On the 2d of May, at about 6 A.M., after a quiet night, there was a sudden severe hemorrhage from the right nostril and throat, originating from the posterior surface of the right tonsil and vicinity, allayed by the application of dilute vinegar by means of Weber's nasal douche, and the application of ice-bags accompanied by the internal exhibition of ice.

The patient, who was considered reconvalescent, was greatly reduced by this accident. Speaking and swallowing, however, were very much easier from this time.

Symptoms of fever again appeared; the accompanying increase of temperature but slightly exceeded 38° C. however, and, together with the reappearance of albumen in the urine, continued till May 9th, when the pulse again fell to 72, and the temperature decreased to 36.9. From this date the patient convalesced rapidly, so that on the 21st of May she was able to drive out for the first time. She was able to remain out of bed for a long time every day, the appetite and strength increased, and there was but one thing to be seriously regretted: there was renewed difficulty in swallowing, in so great a degree that food could be taken only in a recumbent position and very slowly swallowed, a result of the occurrence of partial paralysis of the right velum palatinum (the posterior pillæ being drawn backwards).

On the morning of the 30th of May serious symptoms suddenly re-occurred. For the first time during her illness there was a severe attack of sneezing, followed by acute pain in the right ear, extending over a portion of the right side of the face. In hope of finding relief, the patient lay upon a sofa and pressed the right side of the face upon a pillow for the sake of warmth. The pain, however, increased every moment and extended over the whole side and down into the neck. About an hour later an examination was made.

The palate exhibited a slight line of coagulated blood, which was attached to the right velum; beyond this there was no change in appearance. The pain extended over the right side of the face, neck, and

throat, and was described by the patient, who had heretofore shown great fortitude, as being most intense. The hearing power in the right ear was reduced to a minimum.

Examination with the speculum showed the membrana tympani to be uninjured, of a brownish-red color, and pressed outwards, rendering it convex. The patient was immediately placed upon the left side and ice applied to the right side. The pain thereupon gradually diminished, and she thought she heard crackling noises, and occasionally a "trickling downwards within the ear," which latter sensation could not be explained by examination; towards evening the pain had ceased, but an examination of the membrana tympani showed no change.

The following morning (May 31st) the upper third of the membrana tympani was decidedly paler, while the lower two-thirds were still of a reddish-brown color.

There were some subjective noises, the hearing was improved, but was still far below the normal standard.

During the next few days the abnormal coloring of the memb. tympani gradually diminished.

On the 4th of June Prof. Moos had the kindness to examine the patient. The hearing distance for a moderately loud voice was seven paces, for the watch (six feet normal distance), five inches. The tuning-fork placed upon the head was heard only upon the right side. The memb. tympani appeared of a light brown color, with diminished light spot, but without substantial abnormality in curve. The manubrium was plainly visible. Swallowing with closed mouth and nostrils produced no change. Under the circumstances paracentesis was not admissible, but the air-douche was employed with good results. The subjective noises were only occasional, and soon disappeared entirely. The hearing power became normal, but the right ear remained for some time exceedingly sensitive to loud tones and sounds. It was a long time also before the power of swallowing was perfect. A stay of several weeks upon the Rigi contributed much to a perfect recovery.

The diphtheria was in all probability accompanied by a hyperæmic condition of the mucous membrane of the Eustachian tube and tympanum, originating at the time of the second attack (21st, 22d), at which time decrease in the hearing power and occasional subjective noises appeared.

The severe attack of sneezing, occurring on the morning of the 30th of May, may be taken as the circumstantial cause of the sudden hemorrhage. A true diphtheritic affection of the tympanum, occurring in the way of simple mechanical transplantation, is less probable: the pain in the ear would have been of longer duration, and there would probably have been a perforation of the memb. tympani.

Bartel describes such cases in his observations upon the Häutige Bräune (Deutsches Archiv für Klin. Medicin, Vol. II., No. 445, p. 384).

The hemorrhage was probably increased by the attempt on the part of the patient to gain warmth and relief by turning the right side of the face downwards and pressing it into the pillow. Whether the severe sneezing caused the rupture of the hyperæmic blood-vessels by simple shock, or by sudden condensation of the air in the tympanum, remains an open question.

The latter—rupture from condensation of air in the tympanum—is less likely, because in such cases, as in hooping cough, there is also generally a rupture of the memb. tympani. The severity of the pain, and its ex-

tent as above described, is by no means strange, when we consider that the hemorrhage occurred suddenly, into a space so rich in nerves as the tympanum.

Whether the sensation of "something trickling down within the ear" corresponded to the exit of the blood from the tympanum, I leave without remark.

A CASE OF IDIOPATHIC DIPHTHERIA OF THE EXTERNAL MEATUS.

BY S. MOOS.

Translated by C. J. Blake, M.D., Boston.

THE expectation of being able to report several cases of primary diphtheria of the external meatus induced me to defer the publication of the following case, which I had observed as long ago as August, 1865.

This expectation is as yet unfulfilled. This publication may possibly, by drawing the attention of practising physicians to this apparently rare affection, enlarge the record of such cases. Among otologists, Wreden is so far the only one who has made any observations in relation to it.

Carl Bauschliger, son of a jailer in Heidelberg, ten years old, was repeatedly under my care for purulent catarrh of the middle ear, left side, the first time on July 24th, 1864. On the 20th of November, 1864, he was discharged from the first period of treatment with a cicatrix in the anterior inferior segment. Shortly after he was attacked with the measles, which was accompanied by an acute inflammation of the tympanum on the left side, with perforation of the cicatrix, and otorrhœa.

The treatment on this occasion lasted from the 29th of January to the 19th of March, 1865. The otorrhœa ceased, but there remained a perforation in the anterior inferior segment.

On the 18th of August, 1865, he was again affected with trouble of the ear. His mother stated that since mid-day of the day but one before, he had constantly complained of pain in the left ear, rapidly increasing in severity and lasting day and night. In addition, there had been fever at the commencement of the attack, loss of appetite, excessive thirst, and during the last night even delirium.

There was no difficulty in swallowing, but mastication was impossible. The boy, who had never looked remarkably well, was very pale and exhausted, with a weak pulse, 108 in a minute, and furred tongue; the palate, tonsils, etc., were, however, clean. Traction upon the auricle and pressure about the tragus caused much pain; the same with the swollen glandulæ concatenatæ on the left side. The inner surface of the concha was of a bright red color.

The posterior surface of the tragus, the regio intertragica, and the whole surface about the outer end of the meatus, the inner portion of which could not be examined on account of the degree of contraction, were covered with a rather thick, inflexible, lardaceous, greasy coating. It could not be raised from the underlying structure: the attempt at separation resulted only in tearing the parts matted together, which was attended with bleeding and expression of severe pain on the part of the patient. With the exception of the conduction through the bones, the hearing power was almost entirely lost on the affected side.

There was no positive otorrhœa, but the ear had a very offensive odor. The affected parts were pencilled daily with argentum nitricum (gr. 15 ad ℥ j.), and frequently washed with lukewarm water, and for the relief of the pain cold applications of Goulard's solution (1 to 3) were employed with good effect. On account of the pain attendant upon mastication, only fluid food—at first milk and later strong broth—was allowed. Exception was taken to local bloodletting on account of the poorly nourished condition of the patient. There was still fever, loss of appetite, and restlessness at night.

On the night of the 26th and 27th he was able to sleep.

On the 27th the coating about the tragus and entrance of the meatus commenced to peel off, accompanied by slight suppuration and considerable hemorrhage.

On the 29th of August exfoliation commenced in the meatus, accompanied by increased hemorrhage. There was now for the first time a decided decrease in the pain, syringing having been followed by a pretty considerable hemorrhage.

On the night of the 2d and 3d of September there was a repetition of the bleeding from the left ear, but without pain.

On the morning of the 3d of September the patient was free from fever and had increased appetite.

The hearing distance was five inches for a watch of six feet hearing distance, and eight paces for the voice; and there was but a slight degree of tenderness of the ear on traction or pressure. The spots upon the outside of the tragus, etc., as described, now showed a sharply marked edge with a slightly granulating and suppurating surface; the external meatus presented the same appearance; the swelling had decreased, and a speculum could be easily introduced. After syringing, which was accompanied by a very disagreeable odor, the defect in the anterior inferior segment of the membrana tympani already described could be plainly seen; the rest of the membrane was covered with pus and of a grayish-red color; the membrane was not plainly visible, but the condition which had been expected, from that of the external meatus, could not be determined, either on the membrana tympani or beyond it in the tympanum, even after repeated syringings.

From this date the affection of the external meatus rapidly improved, but the purulent catarrh of the middle ear again grew worse, so that the patient remained under treatment till the 22d of October, when he was discharged in the same condition as on the 19th of March, 1865.

In support of the diagnosis, that in the preceding case there was really a diphtheritic process in the exter-

nal meatus, but few of the symptoms presented can be considered as characteristic.

Of the affections of the external meatus which have been clinically observed, the otitis acuta diffusa externa only can be admitted to consideration. In this affection fever, gastric symptoms, pain—increasing till it is almost unbearable, and rendering mastication difficult—and diminution of hearing, may also be present. Such severe cases, however, generally only occur as the result of excessive external influences, which were wanting in this case. On the other hand, the objective symptoms are very different. An examination at the commencement of otitis acuta diffusa externa shows the meatus to be dry, swollen, and slightly reddened. The congestion rapidly increases, the moistened layer of epidermis becomes loosened, and is followed by an excessive exfoliation of epithelium, which either plugs up the meatus or comes away in shreds, sometimes in a mass, like the finger of a glove, or—as is generally the case—there is an excessive muco-purulent secretion, which leaves the cutis of a flesh-red color and bleeding freely. The secretion is readily removed by syringing.

Of the objective symptoms above described which may be considered as characteristic, are, the inflexible lardaceous exudation, firmly attached to the subjacent parts, and remaining for several days, its exfoliation followed by a greater or less degree of hemorrhage. Exfoliation of epithelium or positive otorrhœa does not appear before the separation of the exudation.

The negative results on examination of the throat, the appearance of the membrana tympani, and the condition of the tympanum, so far as it could be determined through the perforation, hardly leave room for a doubt but that *this was a case of primary diphtheritic affection of the external meatus.*

Wreden has observed five cases of Diphtheria of the ear, and in those most carefully noted the membrana tympani was implicated. (Compare Monatsschrift für Ohrenheilk., Jahrgang II., No. 10.) In our case the change in the membrana tympani must be referred to the previous affection. The purulent catarrh which had existed for some time, and which required a still further course of treatment, was evidently renewed by the later disease.

CYSTICERCUS INTRA-OCULARIS.

By Dr. J. HIRSCHBERG, OF BERLIN.

Translated by Dr. Joseph Aub.

It is a well-known fact that in its earliest stage the recognition of a cysticercus* situated in the background of the eye—whether under the retina or in the vitreous body—in the great majority of the cases is a pretty easy matter, and since it is based upon direct observation with the ophthalmoscope it is also absolutely certain. During the further growth of the entozoon, and the increase of the peculiar opacities of the vitreous body caused by its presence, the diagnosis becomes more difficult; † and finally, the direct observation becomes altogether impossible, on account of the increasing dimness

* *A. v. Graefe*, Arch. f. Ophth., I., 1, 453, etc. I., 2, 326. II., 1, 259. II., 2, 334. III., 2, 308. IV., 2, 171. VII., 2, 48. X., 1, 205; and especially XII., 2, 174–198. *Liebreich*, ibidem, I., 2, 343, and Atlas of Ophthalmoscopy, p. 18 and Plate VII. *Schweigger*, Lectures on the Ophthalmoscope, p. 59, and Arch. f. Ophth., VII., 2, 53. *Mauthner & Becker* in the former's book on Ophthalmoscopy, p. 461; and *O. Becker*, Journal of the Physicians of Vienna, 1865, 385. *Busch*, Arch. f. Ophth., IV., 2, 99. *Nagel*, ibid., V., 2, 183. *Jacobson*, ibid., XI., 2, 147; and others.

† *A. v. Graefe*, Arch. f. Ophth., XII., 2, 183.

of the refracting media, and especially the lens. In these latter stages, cyclitis and phthisis bulbi * mostly supervene; rarely the opposite condition, viz., glaucomatous inflammation.† Both of these painful complications not infrequently require the removal of the globe—the former on account of threatening sympathetic trouble of the other eye, the latter from the similarity of its symptoms with those of intra-ocular tumors. And, indeed, it has happened in several cases that after the enucleation of such eyeballs, cysticercus was unexpectedly found at the anatomical examination; as, for instance, by *Jacobson*,‡ in a totally atrophied globe, and also by the author, in an eyeball enucleated by *Prof. v. Graefe* for severe glaucomatous inflammation and blindness.

More interesting, however, are those cases where, the total opacity of the refracting media rendering a view of the inner portions of the eye impossible, the diagnosis of cysticercus intra-ocularis was made by way of exclusion, after an accurate anamnesis and examination of the case, and corroborated by the subsequent opening of the eyeball. Such a diagnosis would indeed, as *Prof. v. Graefe* in reporting a case of this kind § remarks, lose of its prac-

* L. c., p. 187.

† *Hirschberg*, Virchow's Archives, XLV.

‡ Arch. f. Ophth., XI., 2, 162.

§ Arch. f. Ophth., XI., 3, 145, Note.—Dr. Steffan, of Frankfurt a. M.,—Clinical Experiences and Studies, 1869, p. 66,—makes the following remarks about a puzzling case of spontaneous formation of pus in the vitreous body immediately behind the lens:—"A cysticercus could easily produce the same series of symptoms; yet it seems to me that this diagnosis would hardly be justified in this section of the country, where this entozoon is relatively so rare."

tical importance in countries where, unlike ours, cysticercus is relatively infrequent.

A case similar as regards the diagnostics came under my observation a short time ago, and afforded me at the same time the much-desired and rare opportunity of studying anatomically, after the enucleation of the affected eyeball, the changes caused by the presence of the entozoon.

November 25th, 1869, a strong and healthy man came to me on account of violent inflammation and total blindness of his left eye. The blindness had already existed two years; the inflammation had only set in three days ago.

The right eye was normal, vision perfect, yet considerably annoyed in the discharge of its functions by the irritation of its fellow. The left eye was completely amaurotic, and, according to the positive statements of the patient, has had no perception of light whatever for two years. Form and size of the eyeball unchanged; peri-corneal injection marked; iris considerably swollen and discolored, its pupillary margin extensively attached to the greenish opaque and somewhat swollen lens; tension of the eyeball not increased; great sensibility of the ciliary region when touched.

As there was no reason, either in the external influences or in the shape of the eyeball, to suppose a complicated cataract, and especially no symptom whatever pointing to an idiopathic detachment of the retina; moreover the perfect rest and the normal tension of the eyeball, amaurotic for two years, arguing against the existence of an intra-ocular neoplasm, nothing but cysticercus intra-ocularis was remaining as a diagnosis of probabilities. When, notwithstanding the use of atropine and antiphlogistic as well as derivative treatment, the state of irritation, the pains, the tension of the left eye, and especially the annoyance of the right eye, considerably increased, so that it could hardly be opened in the direction of the light, we were no longer in doubt that

surgical interference was demanded. Attempts at extraction of the worm were of course out of the question. I removed the eyeball on the 1st of December, whereby the patient was relieved from all pain, and the other eye from all further irritation.

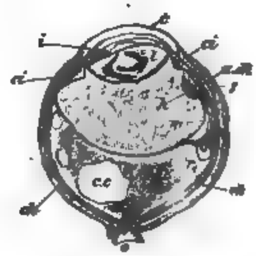
As regards the ætiology I will here remark, that whilst the patient is altogether free from tapeworm, his wife is troubled with it, having at different periods passed large pieces, one nine inches in length.

The extirpated eyeball was opened by a horizontal section after hardening four days in Müller's solution. Only a very small quantity of yellow fluid escaped.

After the completion of the section a folded membranous mass was seen, which proved, upon closer inspection, to be a magnificent specimen of full-grown cysticercus: length of the collapsed mass 14 mm., greatest width 8 mm., head and neck well developed, and on the latter a very strong and well-marked pigmentation of the four suckers, as it is generally seen in a relatively old age of the parasite; all these parts were so delicate and well preserved, that undoubtedly the cysticercus, at the time of the enucleation, was alive, and only the immersion of the specimen in Müller's fluid was the immediate cause of death.

The examination of the section surfaces of the eyeball—that of the upper half of the specimen being represented in the accompanying figure—shows (apart from the iritis, opacity of the lens, or membranous and hemorrhagic products in the atrophied vitreous) *an extensive detachment of the retina, occasioned by a subretinal neoplasm, composed of soft granulation-tissue, in which a large cavity represents the nest of the cysticercus.*

The sclero-corneal capsule remains unaltered. The optic nerve, which macroscopically appears entirely normal, sends, after having passed the scleral opening and lost its marrow at the usual place, a hyaline projection,



Description of the Figure.

c=Cornea. *s*=Sclerotic. *o*=Optic nerve. *i*=Iris. *l*=Crystalline lens. *ci*=Ciliary body. *ch*=Choroid. *a.ch*=Detachment of the retina. *h*=Hemorrhage in the vitreous. *m*=Membrane in the vitreous. *r*=Retina. r_1=Thickening of the retina. *g*=Granulation tissue under the retina. *c.c.*=Cavity in g. Nest of the cysticercus.

2½ mm. long and half as wide, into the spongy tissue, which fills the greater portion of the interior of the eye, and then ends abruptly. The uvea presents considerable changes in all its parts. The iris is thickened and covered with a delicate deposit extending into the pupillary field; the pupil is irregular, its margin attached by very easily loosened synechiæ to the anterior capsule of the lens, which appears clouded, not only in the superficial cortical layers, but also in the parts more centrally situated around the nucleus proper. The ciliary body, as well as the most anterior portion of the choroid (which is detached from the sclerotic almost to the equator*), is very

* What seems of importance with regard to sympathetic affection of the other eye may be found in *Mooren*, the Sympathetic Disturbances of Sight, 1869, p.

much thickened in every portion. This retro-uveal space is thread-like on the inner side of the preparation, whilst outwardly it represents a fissure almost 1 mm. in breadth. The choroid is very much thickened, and, more especially, its outer half. It is apparently stratified, since its color from without inward gradually changes from a saturated brown to a light yellow. The remaining space of the cavity of the eye, lying between the inner surface of the choroid and the posterior surface of the crystalline body, is divided into an anterior and posterior portion by a transverse septum, viz., the protruding retina, which lies almost in the equatorial plane.

The anterior portion, the shrunken vitreous, is traversed by pouch-like fine membranes, which originate for the greater part in a large blood-clot, situated in the outer half of the specimen and lying on the inner surface of the ciliary body, and are attached to the anterior surface of the retina.

The retina itself is only loosely connected with the tissue posterior to it, so that it can be lifted from it with a simple microscope needle; and only behind the coagulum mentioned above, where the retina has a knee-like swelling, does it adhere more firmly to the tissue behind it. Microscopical examination shows that it consists of fibrous tissue with a limited number of small round cells, and also of heaps of pigment (derived probably from blood). The

42, etc., accompanied by anatomical contributions from *Iwanoff*; moreover, in the author's pamphlet in *Zehender's* Clinical Monthly, 1869, p. 297; and the paper by *Rosow* mentioned in the author's article.

large sub-retinal space is filled by a compact but soft mass, which, at the narrow peripheral zone,—*i.e.*, there where it borders on the retina on one side, and on the choroid and optic nerve on the other,—appears grayish and somewhat translucent, but in its greatest thickness seems of a saturated yellow color. It is a vascular granulation-tissue; in the yellow portions the same irregular cells seem pressed more closely, and resemble more the pus-cells.

In the centre of the yellow mass, on the section-surface of the upper half of the specimen, is the irregularly round (6 mm. wide and 5 mm. long) opening to a smooth-walled cavity (devoid, however, of a special parietal membrane), which in a direction upwards and forwards increases considerably in size, on the one side being separated from the upper curvature of the sclera only by a very thin layer, and on the other side extending anteriorly almost to the equator of the lens. Whilst in the lower half of the specimen the presence of a cavity is hardly perceptible, in the upper half there is sufficient space to allow a cysticercus of such a respectable size perfect freedom in his lively and elegant movements.

It is a very interesting fact, when we consider the limited number of the anatomical descriptions of eyeballs with encapsuled cysticerci,* that the case before us should bear such a remarkable resemblance to the one described by the author (in Vol. 45 Virchow's Archives),

* Altogether there are hardly six, which are quoted in my first publication on intra-ocular cysticercus, l. c.

and especially should show with equal clearness the anatomical position of the entozoon. In both cases the cysticercus had developed beneath the retina, had caused total blindness by a complete detachment of the retina, and only after two years' loss of sight had produced, by its very exceptional growth, such violent symptoms of irritation that enucleation of the eye-ball was called for.

GRANULATION TUMORS OF THE IRIS.

BY DR. J. HIRSCHBERG, OF BERLIN,

AND

DR. STEINHEIM, OF BIELEFELD.

Translated from the German by Dr. J. H. Pooley, Jr., of Yonkers, N. Y.

ALTHOUGH simple granuloma of the iris has been known from very early times; although it had found, in the year 1834, at the hands of C. G. Linke, an unusually classical description for that time, and although Prof. Von Graefe has lately reported two cases by which he gave a clear illustration of the clinical and anatomical conditions of this rare affection, still a more complete description is wanting in the usual text-books of ophthalmology, as well as in the well-known treatise on tumors by Prof. Virchow. Such a description is all the more desirable, as in the latest periodical literature a few cases have been recorded of which it is doubtful whether they belong to the so-called benign forms of iris tumors or to the malignant sarcomata.

A short discussion on this question has already been presented by one of us (H.) on the occasion of the com-

munication of a case of melanotic sarcoma of the iris (Archiv f. Ophth., XIV., 3, p. 285).

We may therefore be permitted to set forth a condensed statement of the more important of the older observations as an introduction to a new case of granulation tumor of the iris.

In general, really progressive neoplasms of the iris are very rare, but the more interesting, because they are over-arched by the transparent and equally resistant cornea as with a capsule of glass, and thereby completely protected from all external injuries which might change their natural appearances and growth. Moreover they afford, by their being directly observable to the naked eye of the examiner, one of the most beautiful and convenient objects of onkological study on the living body. Thus it is not surprising that already in publications of the last, and the beginning of this century, the iris has been positively alleged to be the origin of the formation of tumors.

But C. G. *Linke* was the first, in his most talented work, "De Fungo Medullari Oculi" (Leipzig, 1834, p. 156), to give an exact description of the form of tumor with which we are dealing. The following descriptions are collected in his work:—

1st. Maître Jean (Traité des Maladies de l'Œil, p. 456, Troyes, 1711). Fungous growth in a soldier which proceeding from the iris, after rupturing the cornea, projected beyond the lids. Under caustic treatment permanent shrivelling and cicatrization.

2d. Saunders (A Treatise on some Practical Points Relating to the Diseases of the Eye, Lond., 1816, p. 142–144). A girl of ten years was blind of one eye, the conjunctival vessels injected, iris attached to the cornea by a vascular mass, pupil wide, refractive media clear. Opacification of the lens, proliferation of the vascular tumor, occupying the whole anterior hemisphere of the globe, and final atrophy followed. Pain had always been moderate.

3d. Ibid., 144–145. In a little boy three years old, the lower part of the iris was apparently occupied by a small deposit of lymph, without change in the pupil.

The new formation became organized, grew, reached the cornea, perforated it with a spongy swelling, which finally spontaneously disappeared.

4th. *Ritterich* (Jährliche Beiträge zur Vervollkommnung, etc., Leipzig, 1827, p. 37). In a cachectic girl of eight years there appeared a whitish tumor on the inner circle of the iris, which occupied most of the pupil to the ciliary margin, and grew towards the posterior surface of the cornea, whilst its yellowish surface became covered with blood-vessels. After an incision it enlarged so much as to cover the whole pupil, and only a small margin of the cornea remained free. At the expiration of a year, spontaneous atrophy of the globe ensued, and the cornea was changed into a dense cicatricial mass.

5th. *Lawrence* (Lancet, X., p. 514, 1826, and Treatise on Diseases of the Eye, p. 593, 1833). Observed in a boy a fleshy vascular swelling of the iris, which per-

forated the cornea and grew out into a fungous mass, ending in spontaneous and permanent collapse of the eyeball.

6th. *Rosas* (Handbuch der Theoretischen und Practischen Augenheilkunde, 11, 617), found in an otherwise perfectly healthy woman, 40 years of age, a tumor occupying one-third of the iris, whilst the rest was perfectly normal.

After the removal of the tumor by excision of the affected portion of the iris it did not return. (Sight remained, reduced to quantitative perception of light.)

7th. *Sichel* (Cannstatt, über den Markschwamm des Auges und das Amaur. Katzenauge, 1831), observed in Jäger's clinic, in a cachectic child one year old, a whitish-red nodular tumor, which projected through a perforation of the inferior part of the cornea and resulted in atrophia bulbi.

The child died of phthisis mesaraica and hydrocephalus acutus. The tumor originated from the ciliary body, and had grown between the iris and the cornea; the rest of the eye showed only changes common to atrophy.

Praël senr. (Von Graefe's und Walther's Journal, XIV., p. 388) observed in one eye of a child a round yellowish tumor of the iris, which pressed it backwards and rendered the pupil oval. After remaining stationary for six months it finally caused pain, perforation, and atrophy. The concluding sentence of Linke deserves to be copied verbatim :—"Hi enim iridis fungi pertinere viden-

tur ad peculiares luxuritiones, quæ non ex cachexia universali prodeuntes initio in certam corporis partem vim exerceant et postea totum corpus corripiant, sed potius ex vitio locali enati solitariam quasi vitam degant et, ubi certum fastigium fuerint assecuti, denique emoriantur. Putaverim equidem, si irritationem et abundantiam vasorum iridis in exordio et progressu morbi respiciam, *huius modi fungos ex præternaturali* retiformium plexus *vasorum* iridis corporisque ciliaris *dilatatione*, amplificatione et prolongatione *una cum nimia telæ cellulosæ vegetatione proficisci.*"

During the following twenty-five years the existence of this disease seems to have been almost entirely forgotten. Whether McKenzie's case (Traité, etc., 11, 265, 14th ed.) belongs to it is questionable.

Prof. *Von Graefe* (Arch. f. Ophth., VII., 2, p. 37, 1860) observed in a girl a year old, besides moderate ciliary injection, cloudiness of the aqueous humor, and a few posterior synechiæ, a dirty yellow, nearly hemispherical tumor, with nodular surface, attached to the tissue of the iris, which slowly increased, but at last perforated the cornea, and projected as a spongy yellowish-white prominence, from which exuded a small quantity of thin pus. Prof. Virchow found in a part of it parvi and multicellular connective tissue, with myéloplaxes and fat; and Prof. Billroth, two months afterwards, mucous granulation tissue. The swelling grew, apparently in a fungoid manner, to a diameter of 6‴, upon which, in consequence of pressure with a bandage and touching with cupri

sulph., a retrogression and permanent atrophy took place. Lues congenita could not be proved; nevertheless the proliferation process appeared to have been dependent upon a dyscrasia. *L. Wecker* (Etudes Ophthal., 11, p. 430, 2d ed.) considers the case as one of condyloma iridis, which opinion is probably incorrect: compare Archiv f. Ophth., XIV., 3, p. 278, No. viii. McKenzie, Traité, etc., 4th ed., p. 261, considers the case a scrofulous tubercle.

10th. *A. Von Graefe* (Archiv f. Ophthal., XII., 2, p. 231, 1866) describes a second case already with the definite designation, "granulation tumor" of the iris, in a child two years of age. The parents stated that, six months before, a yellowish tumor formed in the lower part of the iris, enlarged by degrees, and perforated. The globe was atrophied but irritable; the cornea extensively opaque; part of it, as well as the adjoining sclera, replaced by a new formation, which resembled the granulations of an indolent ulcer, was 5‴ in diameter, and rose scarcely 1‴ above the level of the globe. The mass was soft, yellowish gray, composed of flat granulations, disposed to bleed, between which there was a slight secretion of pus. Enucleatio bulbi. Upon section it was seen that the iris and ciliary body as well as the anterior part of the choroid participated in the tumor; the greater part of the cavity of the globe was filled with fluid. Structure of the new formation similar to that in the first case (also giant cells).

11th. The following case, taken from "Mooren Oph-

thalmiatrische Beobachtungen," 1867, p. 125, although described under another name, viz., telangiectasis of the iris, belongs likewise to this form of tumor. In a Dutch merchant was seen (21st April, 1858), upon the external part of the iris of the right eye, a swelling of at least one year's duration, of the size and appearance of a blackberry, extending into the pupillary region, joining the cornea, and covered with enlarged vessels.

Fundus and vision normal; at each brisk bending forward of the head the whole anterior chamber filled with light red blood,* which reduced sight to quantitative perception of light, but after a minute and a half of rest always disappeared again. Operation not permitted. On the 15th of May, 1862, since the bleeding had disappeared for a year, the tumor was diminished to one-third of its former volume, and had undergone a change to a grayish yellow; considerable disturbance of sight (Jaeger 16), diminution of the field of vision, and slight displacement of the vessels in papilla optica, glaucoma secundarium. Iridectomy again refused; only permitted when, a few months later, sight had wholly disappeared, and the most severe ciliary neuralgia had set in. The tumor removed by the operation was unfortunately lost.

The second eye suffered later from sympathetic irido-choroiditis, but was cured by iridectomy, and the tenderness of the stump of the first diminished. The clinically

* A similar observation of hemorrhage from the apparently perfectly normal iris, upon bending the head, has been communicated by A. Weber, Archiv f. Ophth., VII., 1, p. 65.

very peculiar features of this case evidently resulted from the preponderance of blood-vessels in the tumor.

12th. We include here likewise the case briefly described and illustrated by Dr. *Schelske* (Lehrbuch der Augenheilkunde, 1870, p. 84) of telangiectasis of the iris; if we are not mistaken, it is the same as has been demonstrated by Prof. Von Graefe some time ago in his clinic, with the remark that he considered it a granulation tumor.

There was seen in the lower part of the iris of a young man a reddish yellow mass, with dilated vessels, the growth of which was exceedingly slow.

To these cases, so far described, we have to add the following:—

(No 13.) G. S., a peasant, 21 years old, of slender build, but in robust health, came on the 7th of May to one of us (St.) on account of his right eye, with the statement that some months ago a splinter of wood had flown against the eye,* and caused a protracted redness at its lower part. He had afterwards noticed a white spot in the eye, gradually increasing, and that the power of vision had somewhat decreased. At the examination the eye appeared free from irritation, and its outer coats quite normal; there is no cicatrix to be discovered. The cornea is transparent as far as its margin, only a little congested in its lower periphery, in consequence of the marked venous congestion of the conjunctiva

* The part played by the wound in this case is obscure. Knapp (Intra-ocular Tumors, Eng. ed., p. 300) speaks more at large of the traumatic granulation tumors of the eye.

In a large dog we observed a mushroom-shaped red granulation tumor, which projected through an opening made by sloughing of the cornea, was produced, according to the statement of the owner, by a blow with a piece of wood, and had remained stationary for more than a year.

scleræ. The iris is completely covered in its lower half with a yellowish flesh-colored vascular mass, slightly nodulated on its anterior surface, which begins immediately on the ciliary border, reaches to the lower margin of the pupil, filling the lower portions of the anterior chamber to the posterior wall of the cornea, with which it is closely connected, whilst its upper part gradually decreases in thickness. The upper half of the iris is normal, and of the same slate-gray color as that of the healthy eye. The pupillary margin is fastened to the lens by several synechiæ; the interior of the eye, however, is visible, where no changes are perceptible; the power of vision is scarcely diminished, and the field is not abridged, nor the power of accommodation influenced by the synechiæ. Enucleation was out of question at the time; the patient was informed, however, of the eventual necessity of this emergency. On the 8th July, 1868, at the expiration of a year, he returned, with a materially altered condition of the eye. It was reddened by strong venous injection, lachrymating, hard, and completely blind. At the lower margin of the cornea flesh-colored tumors, separated from each other, were projecting over the level of the cornea, extending, the size of a small hazel-nut, and half as much in height, over the adjacent sclerotic. This portion was covered by slightly uneven injected conjunctiva, resistant to the touch, and completely attached to the sclerotic; between both portions remains a small zone of altered cornea and normal sclerotic. The cornea therefore participates in the process of degeneration, decreasing from below upwards.

Only a small superior part of the iris is visible, manifesting inflammatory changes; upper margin of the pupil adherent and covered with exudation.

On the 9th of July enucleation was performed; the wound healed in a short time; relapse did not occur. At the end of 1869, a year and a half after the enucleation, the patient was quite well, and without the trace of a tumor in the orbit or any other part. The globe, which was hardened in alcohol for a long time, was divided in the vertical meridian, whereby the dissolved vitreous was evacuated; the neoplastic changes were confined entirely to the anterior segment of the globe.

The sclerotic also was thinned in its posterior part, but neither it nor the choroid showed any traces of a tumor.

A moderate, circumscribed thickening of the retina in the neighborhood of the optic nerve entrance, the radius of which is about from two to three diameters of o. d., must be referred to a purely irritative process (neuro-retinitis), as the microscopic examination demonstrates considerable hypertrophy and sclerosis of the fibrous layer to be the cause of the swelling of the retina.

On the contrary, the space of the anterior chamber and the lens—of the latter no trace is discoverable—is replaced by a solid, soft, new formation, which no doubt derives its origin from a hyperplasia of the corpus ciliare and the iris. The mass is homogeneous, of whitish gray color, with a shade of red; posterior surface, looking towards the vitreous space, tolerably smooth.

In the upper part of the anterior chamber, the anterior surface of the new growth shows still a remnant of uveal pigment, in the shape of a small stripe, and lies in close contact with the still transparent cornea, so that by means of the dissecting-needle a slit-shaped opening can be made between them. In the axis of the eye the new formation is united with the staphylomatous cornea, likewise with the thin zone of sclerotic near the lower margin of the cornea. A fine brown line is still recognizable even with the unaided eye, being the remnant of the outer coats of the eye.

The microscopic examination shows as uniform constituents of the new formation a vascular, fibrous, parvi-cellular tissue. The stroma of parallel fibres is richly developed, and even in fine sections, which are not cleaned by a brush, prevails over the cells. The cells are roundish and irregular (shrivelled by alcohol), occasionally short, spindle-shaped, with distinct nuclei, a little larger than that of red blood corpuscles; here and there also many nucleated (myeloplaxes), and consequently larger than the others, whilst proper giant forms are missing.

It is clear that such a structure well deserves the

name of granulation tissue; but it is just as evident that its histological differences from certain forms of sarcoma are only unimportant. If there were any further proofs needed that the microscopic examination of the neoplastic tissue of itself, without regard to the matrix from which it proceeded, is not sufficient to decide upon the pathological importance of the product, the proof would be furnished in these tumors of the iris. Let us recollect that even Prof. Virchow,* in his first histological analysis of a specimen of granuloma iridis, did not express himself definitely on the nature of the formation. Only further special clinical experience justifies us to-day in the conclusion that, if we find any such unpigmented granulation-like structure in a neoplasm of the iris or ciliary body, we need not fear a recurrence or metastasis in remote organs after the complete removal of the diseased parts.

This reason, together with the consideration that the function of the organ is lost in the natural course of the disease, encourages us in surgical interference at an early period of the disease, viz., when vision is still good, and may be preserved by removal of the iris constituting the matrix of the neoplasm. On account of the peripheric origin of the new formation, great difficulties may arise in the performance of the iridectomy, which may best be obviated by using a small knife. In the later stages, after the loss of vision brought about by the growth of the new tissue, there are always symptoms of

* Arch. of Ophth., VII., 2, 38 Mitte.

secondary glaucoma. Enucleatio bulbi would then be preferable to attempts to produce shrivelling of the globe, as the former is quicker and surer, and leads to the same end without danger, which is to free the patient of his disease; and this would be necessary in an earlier period, in case the differential diagnosis from malignant sarcoma cannot be made with certainty.

The relatively youthful age of the patients, the yellow or reddish, decidedly not melanotic color, the uneven surface, and the macroscopic vascularity, the very slow increase of the growth, which projects quite gradually from the iris tissue, might argue for the existence of granuloma, while in the one certain case of sarcoma of the iris the neoplasm presented a smooth, uniformly bluish-black surface.

DO THE EYES PERFORM ANY ROTATION ON THE OPTIC AXES IN LATERAL INCLINATIONS OF THE HEAD?

By Dr. JOSEPH AUB, of Cincinnati:

Assistant-Surgeon to the New York Ophthalmic and Aural Institute.

In a paper published in Vienna during the course of the past summer, by Drs. *Reuss* and *Woinow*, under the title "Ophthalmometric Studies," the latter author makes the remark that Prof. Knapp's method of measuring the curvature of the different meridians of the cornea, by means of a new apparatus for fixing the head, was inaccurate; and for this assertion he gives the following reasons:—

1. The impossibility of bringing the head in exactly the required meridian.

2. The involuntary wheel-turning of the eye consequent on lateral inclinations of the head.

This latter statement being at variance with the results of experiments made by Prof. *Donders* about twenty years ago, Dr. Knapp induced me to make new inquiries into the subject, and suggested the method according to which the following experiments were conducted. The

researches of Donders had only shown, in a general way, that when the head was inclined to either side, the eye did not, as was formerly supposed, rotate upon its axis, so as to keep the vertical meridian always vertical, but that the eye moved in the same direction as the head—that is to say, maintained its relative position to the head.

It is the object of the following investigation to determine whether the eye makes any rotation on the optic axis when the head is inclined to either side, and if so, of what amount it is.

I employed the new apparatus, constructed after the design of Dr. Knapp, for holding the head fixed during observations with the ophthalmometer. The essential part of this apparatus is a dial which is divided into degrees, and turns in an immovable frame. The head is fixed to the dial by lateral pads and a projecting mouth-piece, bearing a cast of the teeth in sealing-wax. *Thus the skeleton of the head is brought in immovable connection with, and must perform the same rotations as, the dial.*

An index on the immovable frame shows how many degrees the head is inclined laterally. If it is possible to determine with the same accuracy the lateral inclination of after-images of the retina, then we are able to find out whether, during lateral inclinations of the head, the eye maintains its relative position to the head or not. The inclination of after-images was determined in the following manner:—

On a wall, twenty feet distant from the observer, I

fixed two pieces of small red ribbon, crossing each other at right angles, one being vertical, the other horizontal. From the crossing-point of the ribbons I described a circle with a radius of 9 inches, and divided it into degrees. The centre of the circle was at the same height as the eyes of the observer. The head being immovably fixed to the dial of the apparatus, and in a vertical position, the observer gazed steadily at the crossing-point of the red ribbons for about half a minute, so as to obtain a distinct after-image. Then the head, together with the dial, was rapidly turned laterally, and the observer, uninterruptedly gazing at the crossing-point of the ribbons, could determine, on the circumference of the circle, how many degrees the after-image was inclined. Some difficulty here manifested itself in exactly determining with which degree the ends of the after-images coincided, since this could only be seen in indirect vision, the eye fixing the centre of the circle. The observer was liable to interrupt the fixation of the centre, in order to see more distinctly the number covered by the end of the after-image; but by so doing his eye frequently made a secondary movement, so that the after-image was shifted to the right or left side of its original position. To obviate this difficulty, radiating cords were drawn from the centre to every 15th degree of the periphery of the circle. If now the periphery was looked at in order to determine the inclination of the after-image, and the eye made a lateral motion, this could be recognized by the fact that the after-image did no longer coincide with the

radiating cord it originally covered, but stood parallel to it, either on the right or the left side. This parallelism indicated just as correctly the original position of the after-image as its coincidence with the cord when the fixation of the centre of the circle was retained. In this manner errors of observation, through the uncertainty of indirect vision, were avoided. The only thing which remained to be done was to compare the degree of lateral inclination of the head, indicated by the apparatus, with the inclination of the after-image, indicated by the graduated circle and its radiating cords.

Repeated experiments of my own and of Drs. H. Knapp, H. C. Scott, Charles Bacon, and some other gentlemen, had the unvarying result that the inclination of the after-image was either the same as that of the head, or deviated from it only 1 to 4 degrees on the one or the other side. Since this slight deviation is to be considered an error of observation, it is proved, contrary to the assertion of Drs. *Reuss* and *Woinow*, that in lateral inclinations of the head and straightforward direction of the visual line, the eye does not make any rotation around the optic axis whatever.

The above experiments confirm, therefore, the statements of Donders and other observers, according to which the eye, in general, follows the lateral inclinations of the head; but these observers failed to demonstrate that this is done exactly to the same degree. This uncertainty is removed by our experiments, which proved that the lateral inclination of the eyes is not only of the

same direction, but also of the same degree as that of the head.

I am unaware upon which investigation the above-quoted assertions of Drs. *Reuss* and *Woinow* are based.

With regard to the accuracy of determining the lateral inclination of the head by means of Dr. Knapp's apparatus, Dr. Knapp requests me to state that the apparatus which he had had constructed, shortly before his departure from Heidelberg, had no mouthpiece, and did not hold the head tightly enough to follow to the degree the rotations of the dial. It was, however, as is conceded also by Drs. *Reuss* and *Woinow*, accurate enough for ascertaining the astigmatism of the cornea after cataract operations, with which Dr. Knapp had occupied himself during the summer of 1868, and obtained results similar to those published subsequently by Reuss and Woinow. The addition of the mouthpiece, not allowing any movements of the head other than those of the dial, combined with the results of our investigations, according to which the eye makes no involuntary wheel-rotation in lateral inclination of the head, renders the apparatus and the method of Dr. Knapp for measuring the meridians of the cornea entirely unexceptionable with regard to accuracy.

THE MECHANISM OF THE ORGAN OF HEARING.

By H. KAISER, M.D., of Dieburg.

Translated from the German by Albert H. Buck, M.D.

To understand the mechanical conditions which play an important part in the act of hearing, especially in man, it is not necessary to commence new studies in higher mechanics or to enter into complicated calculations; the well-known physical doctrines suffice here fully. We shall have to refer to higher mathematics only when we come to consider, in the first place, how the *membrana tympani* can be excited to sympathetic vibration by a sound-producing body, and, in the next place, how the handle of the hammer can so easily follow the vibrations of the membrane without acting as a hindrance.

Whilst studying the present condition of science with reference to the function of hearing, it seemed to us that, on the one hand, certain points were not brought out with sufficient clearness, whilst others were entirely overlooked. In reference especially to the mechanical effect produced upon the terminal nerve branches, whose function is to receive the impressions of sound, we found no explanation that gave us entire satisfaction.

We felt convinced that it was the function of the organ of hearing—which, though relatively simple, is yet complicated when considered by itself—to transmit to the terminal branches of our auditory nerve, in as concentrated a form as possible, the impressions produced upon the superficies of the membrana tympani by vibrations of sound occurring in the medium with which the membrane stands in contact; just like what occurs in the organ of sight, where the corneo-lenticular system transmits in a concentrated form to the retina all the rays of light which proceed from a luminous point, and reach the pupil. And, moreover, the better we were able to understand the function of the individual parts of the auditory apparatus, and the arrangement of its mechanism as a whole, the more we became confirmed in our view.

As in our paper on the mechanism of the accommodation of the eye,* we shall first state the physical and mechanical principles involved in the action of the auditory apparatus, and then consider successively the parts played by the individual elements of this apparatus, reserving for the last the consideration of the function of hearing in its totality, as it will naturally follow from the premises.

I. PHYSICAL PRINCIPLES.

1. Here too, as in the mechanism of the accommodation of the eye, the incompressibility of the aqueous

* Reichert's and Du Bois-Reymond's Archives, 1868, 3.

fluids must first be taken into consideration. Inasmuch as the volume of water is diminished only 0.00005 under the pressure of one atmosphere, we can consider the fluid of the labyrinth as entirely incompressible under the slight pressure to which it is submitted. As a result of this, the pressure made by an aqueous fluid, which is surrounded by immovable walls, upon an object contained within it, is as great as that exerted by a perfectly solid body, whose surfaces of contact are at the same time entirely free from every roughness, for the surface of fluids is perfectly smooth.

2. Waves of sound produced in an open space, or in cylindrical tubes of infinite length, are *progressive.* If l = the length of the waves, and a = the rate of progression of sound in the air, and x = the distance from the centre of concussion, then the vibration at the time t will reach from $x = a\,t - \frac{l}{2}$ to $x = a\,t + \frac{l}{2}$. If, therefore, x' = the distance of a membrane (which is capable of receiving the motion, and vibrating with it) from the starting-point of the concussion, then the wave reaches the membrane at the time $t_1 = \frac{x' - \frac{1}{2}l}{a}$ and leaves it at the time $t_2 = \frac{x' + \frac{1}{2}l}{a}$. The wave therefore traverses, as it were, in all its phases the membrane in the time $t_2 - t_1 = \frac{l}{a}$ —inasmuch as no disturbance is produced by the reflection of the waves, as experience teaches,—and imparts its vibration to it as far as a single shock is able to do. If,

now, the sound-producing cause continue till a certain number of equal waves have traversed the membrane, it will excite in it comparatively strong sympathetic vibrations.

3. In the mechanism of the ear we have not to deal with so-called "standing" waves, as they are formed in tubes of finite length, because the individual spaces and canals of the organ of hearing are too small to produce an independent formation of waves.*

4. Vibrations of sound are easily imparted to a thin stretched membrane, the same as to a thin wooden tablet.

It is well known that the sounding-board of stringed instruments, which consists of a thin wooden tablet, vibrates sympathetically with the strings extended over it, and that the vibrations which have thus been produced in the air impress our organ of hearing with all the force of the instrument, while the vibrations caused by the strings alone are scarcely perceptible.

Stretched membranes are so much the more fitted to vibrate sympathetically with all sorts of tones, as they are able of themselves, on account of their physical characteristics, to produce an infinite number of tones.†

* A consonance of the air contained in the cavity of the tympanum can take place only when, the membrana tympani being destroyed, such tones are sounded the quarter length of whose waves does not differ much from the length of the external auditory canal, plus that of the tympanum. Compare, however, a remark under the heading "*Membrana Tympani*"!

† See Lamé, Leçons s. l. théorie math. de l'élasticité des corps solides, dixième leçon.

A rod moreover, when intimately united to a membrane, and extending from its centre to beyond the periphery, is fitted to follow the membrane in all its vibrations; and indeed the more so from the fact that such a rod will, if caused to vibrate by itself, in accordance with physical laws, carry out just the same kind of undulations as a radial fibre of the membrane.*

* The differential equation for the transverse vibrations of a homogeneous elastic membrane is:—

$$\frac{d^2w}{dt^2} = c\left(\frac{d^2w}{dx^2} + \frac{d^2w}{dy^2}\right),$$

from which, by integration, we find the formula for a membrane stretched over a circular ring of the radius r (it being assumed that the origin of the co-ordinate is in the centre):

$$w = \Sigma A_i\,(H \cos \gamma t + H' \sin \gamma t)\,(2^2 - x^2 - y^2)^i, \quad (\odot)$$

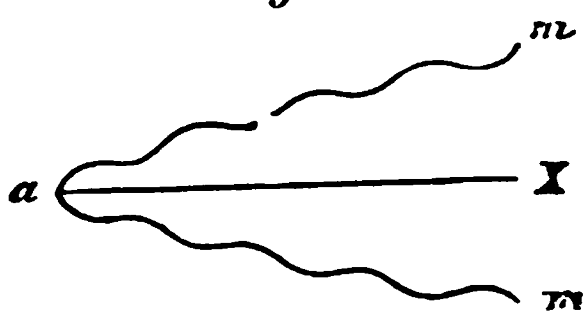
where H and H′ are constant magnitudes, and A_i denotes a factor, which decreases in proportion to the increase of the index i, and is independent of the variables x, y, and t.

The integral for the vibrating motion of a thin elastic rod, according to Poisson (Traité de mécanique, II., page 377), is found in the formula:—

$$y = \Sigma X\,(E \cos \gamma' t + E' \sin \gamma' t). \quad (☽)$$

Although γ' in (☽) is not identical with γ in ($\odot$), nor X with $A_i\,(r^2 - x^2 - y^2)^i$, still from the similarity of both formulæ we may be allowed to draw the conclusion, that an elastic rod (which is interwoven with an elastic membrane and does not materially differ from it in its nature, especially as regards elasticity) can participate in the vibrations of the radial fibres of that membrane without at the same time disturbing its vibrations as a whole. The discussion of the equation $X = 0$ (loco citato) affords only one real positive root, that is $x = 0$.

Fig. 1.



Besides its point of attachment, therefore, the rod has none other which can remain quiet during the motion. The value of X constantly increases with x, and the form of the motion is therefore similar to that represented in Fig. 1, where the two extreme positions of the rod are represented by $a\,m$ and $a\,m'$, and a point in the circular border of the membrane by a.

5. Small volumes of air, or short columns of fluid, when put in motion by vibrating membranes, must be considered as media that are only to be affected in their totality, and uniformly, provided their dimensions are so small in comparison with the length of the waves of sound that their density and rate of speed (when affected by the wave) remain in all the layers very nearly the same.

6. The intensity of sound diminishes according to the square of the distance. The rate of progression of sound in air is 1022 Parisian feet per second. If l represent the length of the wave of sound, a = the rate of progression, and n = the number of vibrations, then, since $l = \frac{a}{n}$ we shall have for *C* of the contra-octave $l = \frac{1022}{33} = 30.97$ feet, and for $\overset{\equiv}{b}$, $l = \frac{1022}{3690} \doteq 0.28$ foot = 3.36 inches.

The length of the wave ranges, therefore, from $3\frac{1}{3}$ inches to 31 feet, or even to 64 feet, if we take the deepest tone which a closed pipe 16 feet long can give.

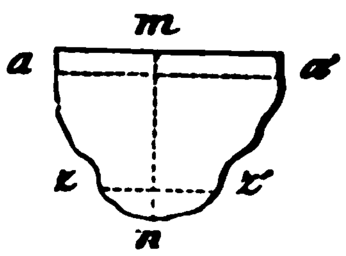
The rate of progression in air being such as we have mentioned it, in water about four times as much, and in solid bodies still greater, the motion of individual vibrating molecules of a stretched membrane is, on the contrary, exceedingly slow.

If the distance traversed by an oscillating particle, during its to-and-fro motion (corresponding to the to-and-fro motion of a wave) be fixed at one-tenth of a millimetre, then, inasmuch as the length of the wave produ-

cing the tone c = 1 metre, the rate of its progression in air will be 10,000 times, and in water nearly 40,000 times greater than the rate of oscillation of a particle of the membrane.*

If air be contained in a space surrounded partly by solid walls, and partly by a vibrating membrane *m* (Fig. 2), and if the space be of so small dimensions that an equally large portion of the wave which causes the membrane to vibrate may be considered as homogeneous with regard to velocity and density, then the vibrating membrane acts upon the air which is contained within the cavity in the following manner:—

Fig. 2.



If the membrane has just commenced its motion, and the layer *a a'*, which is parallel to it, has passed over an infinitely small portion of its course, in the direction *m n*, then the shock has already been propagated also to the last layer, *z z'*. It can therefore be assumed that all the layers of air which are parallel to the membrane approach the opposite wall, *n*, and recede from it on the return of the wave, at the same time and with the same force. It follows from this, that under the conditions just mentioned, a vibration of the membrane has the effect only of a gradually increasing condensation and rarefaction upon the enclosed air.

* The vibrations of all the parts of the organ of hearing are, it is true, isochronous with those of the *membrana tympani*, but yet—leaving out of consideration the air contained within the cavity of the tympanum—they do not exactly equal them in their excursions.

But if a small space surrounded by solid walls, r s (Fig. 3), and shut in by two membranes, m $m_{,,}$ were filled with water, then a condensation of the water, owing to its incompressibility, could not take place; consequently the enclosed water would have to remain perfectly quiet, provided, of course, the pressure upon both membranes were equal. Such would be the case if both of the membranes m $m_{,}$, which shut in the water, were connected with a space m M $m_{,,}$ containing air like the one previously supposed, and the oscillating motion originated in the membrane M.

Fig. 3.

But if the pressure upon m and $m_{,}$ were not the same, that is, if the pressure upon m were greater than upon $m_{,}$, then the entire fluid would move in the direction from m to $m_{,,}$ and continue its course in that direction until the gradually increasing tension of the membranes would oppose an equal force to the pressure exerted upon m. The motion upon the water would gradually slacken, it would come to rest, and then swing back with gradually increasing speed in the opposite direction. The entire mass of the fluid would therefore act like a pendulum, vibrating with a very short excursion.

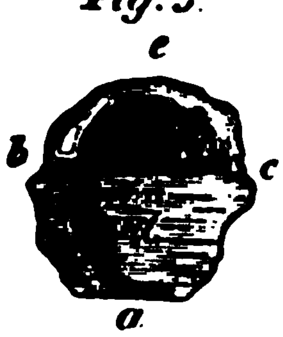
Fig. 4.

If the canal m r s $m_{,}$ (Fig. 4), had a side branch, x, the water contained within it would experience a similar oscillation; in y, moreover, where the courses of the particles

of water cross each other, a sort of eddy would be created.

7. The effect of a force impelling the mass M, if reckoned from the point of time when the velocity of the mass was 0, up to the time when it equals v, may be expressed by $\frac{1}{2} My^2$. The mass M, to which the velocity v was communicated, can now likewise produce the same mechanical effect as the force which has acted upon it. Hence the effective power of a body in motion, whose mathematical expression is $\frac{1}{2} Mv^2$, is called its "vis viva" (potential energy). The greater therefore the value of M, where the value of v remains the same, the greater will be the effective power. Let a b c (Fig. 5) represent three thin stretched membranes, and a united to b by means of a comparatively heavy lever, d. Let the space a b c be filled with air, and the tube b e c entirely filled with water. If now the mass of the lever d be equivalent to M, and the velocity v be imparted to the membrane a, then the energy exerted upon the mass of water in b e c will be expressed by $\frac{1}{2} Mv^2$. But it is clear that this force increases with the mass M of the lever, and that in consequence of the law of inertia the system (comprising the membranes, the lever, and the mass of water which it puts in vibration) will continue its motion even after the cause that put the membrane a in vibration has ceased; and the greater the volume of the entire vibrating system, the longer the motion will continue. If the membrane a possesses a

Fig. 5



regulator which can counteract its vibrations,* then the duration of the oscillation of the system, which, owing to the vis inertiæ of the mass, continues after the external exciting cause has ceased, will depend on the relation of the power of the regulator to the weight of the masses of the system.

It is scarcely necessary to add that these principles may be applied to the organ of hearing as a whole, and also to its component parts. By means of these principles we hope to succeed in giving a clear representation of how this apparatus fulfils the purpose for which it was intended, in as simple though perfect a manner as we might expect from the economy of nature, viz.: to make the most effective impression possible upon the terminal branches of the auditory nerve by means of the waves of sound which enter the ear.

II.—The different parts of the auditory apparatus.

1. The Auricle.—All rays of sound which do not enter directly into the external auditory canal can only reach it by being reflected from the inner surface of the concha. Since the plane, tangent to the anthelix and tragus, forms with the median plane an angle of about 35°, and since both ears are turned symmetrically in opposite directions, there remains a space behind the body which is enclosed by

* In our opinion the *musculus tensor tympani* performs the part of such a regulator of the *membrana tympani*.

two vertical planes forming together an angle of 70°, and within which a direct transmission of sound to the external auditory canal is impossible. Those waves of sound, therefore, which strike the back part of the head within this space, are shut off from the possibility of reaching directly the external auditory canal, whilst all the others that fall within the remaining space of 290°, can reach the ear either directly or by aid of the conchæ. From all sonorous points, however, situated behind the listener, spherical waves proceed, which are disturbed, it is true, by the body of the person whom they strike, but still unite again later into a uniform whole, from which regular waves then travel backwards into both ears. Inasmuch as the intensity of waves of sound decreases in proportion to the square of the distance, and energy is lost through the aforementioned disturbance, these waves will therefore be considerably weaker than the direct waves.

The waves reflected by the conchæ do not differ very materially in point of intensity from those which enter the external auditory canal directly, neither do they differ essentially from these in the magnitude of their phasis—that is, with reference to the length of the waves which we have here to consider. (This is, however, not true of waves reflected from objects more or less remote from the ear, as is most strikingly proven by the phenomenon of the echo.) That the intensity of sound should be so slightly diminished by reflection from the inner surface of the concha, can only be explained by supposing that the waves are reflected without appreciable loss of energy

—a circumstance due to the firmness and elasticity of the cartilage of the auricle. The construction and nature of the latter render it, in our opinion, peculiarly adapted to afford the requisite firmness and elasticity. There may be some truth in the assertion that the form of the concha enables it to present a perpendicular surface to the rays of sound coming from any direction whatsoever, and thus always to convey a portion of them to the external auditory canal; but no very great value can be attached, in our opinion, to this advantage alone.

In animals the concha, with its flap-like appendage, often serves to protect the ear, as the eyelids protect the eye; at the same time it presents a movable funnel for the better reception of the rays of sound and for the determination of their direction.

In man, the direction from which a sound comes is also chiefly determined by the concha, and especially by means of the reflections from its inner surface; the faculty of determining the source of these reflections being gradually acquired from earliest childhood.

On the use of the concha in agitated air, we shall make some remarks in the following section.

2. The External Auditory Canal.—In a mechanical point of view the external auditory canal offers little of interest. Its anterior third, where reflection takes place more than in the deeper parts, is chiefly cartilaginous, and it would seem as if here too the elasticity of the cartilage played an important part. When we compare the length of sound-waves with the narrowness of the canal, we

cannot admit the possibility of any change in the phases of the waves which are reflected from its walls.

The external meatus serves, in the first place, to prevent the transmission of extremes of temperature to the middle and internal ear ; this is accomplished by means of the tempered air contained within the external auditory canal, which acts as a poor conductor. (In animals an abundance of hairs in the external auditory canal serves the same purpose.) By its length, moreover, it protects the membrana tympani from injurious mechanical influences.* In the next place, the disturbing influences caused by frequently occurring violent atmospheric commotions are very much mitigated by the length of the external auditory canal. If, for instance, the membrana tympani were directly exposed to the external air, while the latter was moved by the wind only at the rate of 12 feet per second, then, upon the intonation of any tones below $\bar{a}$, none of the particles of air in the immediate neighborhood of the membrane, owing to the slowness of their oscillations, could complete their vibrations against the membrana tympani ; new ones would constantly come up, which, although being in the same phasis as the preceding, would cause a considerable loss of energy. Moreover those rays of sound which proceed within a short distance from the original surface of vibration, as, for instance, from the section of a person's mouth, speaking

* Politzer (Beleuchtungsbilder des Trommelfells, page 120) speaks of a prairie dog (in which animals the *membrana tympani* lies very near the surface, owing to the shortness of the external auditory canal), in whom he found a fracture of the *manubrium mallei*.

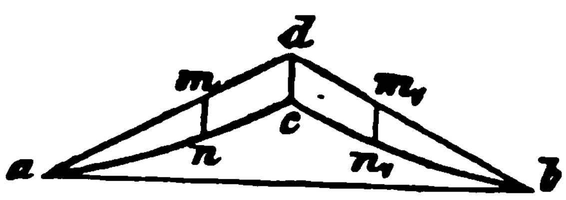
toward the ear of the listener, could no longer reach the membrana tympani; only the weaker side waves would reach it.

At a somewhat greater distance, however, this disadvantage would still present itself, provided the external auditory canal were existing, but the concha wanting. The latter, by its extent of surface, increases very materially the limit within which the most effective rays of sound can reach our ears.

3. The Membrana Tympani.—Sympathetic vibrations are excited in the membrana tympani by a number of uniform undulations, corresponding to the length of the waves of a sound or tone, in the same manner as they are excited in a tuning-fork (armed with a suitable resonator) by another tuning-fork, which is tuned to the pitch of the former, and may be held at a considerable distance from it. The construction and form of the membrana tympani is highly favorable for the important function of conveying to the internal ear, not the waves of condensation and rarefaction of the medium which serves as their substratum, but the periodical and rhythmical molecular motion caused by them. This membrane consists on the outer side of radial, on the inner, of circular tendinous fibres. The former of these are held in a state of great tension by the traction of the handle of the hammer, whilst the latter are only moderately stretched. By the simultaneous action of both, a section of the membrane assumes the form *a*, *c*, *b* (Fig. 6). If now, by a pressure from without, the radial fibres are put on the

stretch whilst the circular ones at the same time yield, then a section of the membrane will approach the form of the rectilinear triangle *a d b*. In a motion of this kind, the particles of air which strike the surface *a c b* lose the smallest possible amount of energy, because all the particles of the membrana tympani move in directions which are nearly parallel to *c d*, and therefore, the moment their inertia has been overcome, they will return by almost the same route as that taken by the particles of air which cause the motion, since the directions *n c*, and *n′ c*, are nearly parallel to *m d*, and *m′ d*.* If the membrana tympani were even, then not only at the border, but also more toward the middle, the vibrating particles of air which act upon the membrane would lose a considerable amount of their energy. Under these circumstances the strength of the effect produced upon the membrana tympani is materially increased, first, by the inclined position of that membrane, as a whole, to the axis of the external auditory canal; and next—especially since the phases of the waves of air which strike it can be considered as perfectly equal—by the considerable increase of its surface.

Fig. 6.



The tension of the membrana tympani may be increased

* During that short interval of time, within which the membrane has not yet attained the speed of the particles of air which excite its motion, the latter, rebounding from the portion *n c*, of the membrane, are thrown mostly upon the portion *n, c*, where they produce their mechanical effect, as those reflected from *n, c*, on the portion *n c*.

by the contraction of the musculus tensor tympani. Since by increasing the tension of a membrane its pitch is elevated, it may be assumed that this muscle is capable of rendering the membrane more sensitive for the reception and transmission of certain tones. In this particular the action of this muscle resembles somewhat that of the ciliary muscle. But even without the assistance of this muscle the membrana tympani must be so disposed that it can vibrate with the many different tones which reach it, otherwise a sudden succession of high and deep tones could not be accurately appreciated, for the tensor muscle would not have time to accommodate itself.* The principal function of the *musculus tensor tympani* seems to be that of a damper [mute] of the membrana tympani, being fitted not only to moderate, by means of strong contraction, too great excursions of the latter, but also to prevent a continuation of the sensation of sound after the production of the waves has ceased.

4. The Cavity of the Tympanum.—The opening in the tympanum which leads to the Eustachian tube has this mechanical importance, that by means of it the tension and temperature of the air in the cavities of the pharynx and tympanum may be kept in a state of equilibrium. In the consideration of the acoustic functions of the cavity of the tympanum, and especially in regard to the question whether they are modified by the occurrence of condensations and rarefactions in the air of the Eustachian tube, it may be stated that, according to the in-

* See E. Mach, Sitzungsbericht der Wiener Akademie, Bd. 48.

vestigations of Prof. Moos, which confirm the views of the older authorities, this tube is closed when in a state of rest.*

As a general rule, the relation of the parts in the cavity of the tympanum to one another is such as is represented in Fig. 5, where *a* designates the *membrana tympani*, *b c* the membranes of the *fenestræ ovalis* and *rotunda*, and *d* the chain of ossicles.

Although the air enclosed within the cavity of the tympanum is alternately condensed and rarefied, it nevertheless differs from a standing wave in this, that all its layers (in almost all cases) are of equal density. Only the waves of very high tones, whose lengths are nearly four times the length of the cavity of the tympanum, can, in the opinion of Helmholtz, create a resonance within that cavity.

If the bones of the ear were wanting, or their continuity broken, there would be an equal pressure upon both fenestræ of the labyrinth, and the fluid contained within it would have to remain at perfect rest. In such a case the presence of an entire membrana tympani (or of an artificial one), besides affording protection against the extremes of temperature, and favoring the conduction of sound through the cranial bones, would render possible the transmission of the vibrations of that membrane in a direction perpendicular to the membranes of both fenestræ, and in the form of periodical pressures upon those membranes. Were no membrana tympani present, the

* See the last paper of this volume.

vibrations of sound in the air, being nearly parallel in direction with those membranes, could affect them only slightly.

The pressure which is exerted upon the membranes of these fenestræ, in consequence of the vibrations of the membrana tympani, can be approximately expressed by

$$\rho\frac{z}{z_{,}-z},$$

where $\rho =$ the pressure of one atmosphere, $z_{,}$ the length of the cavity of the tympanum, and z the distance of a particle of the vibrating membrana tympani from its position of rest. Inasmuch as ρ varies with the height of the barometer, the intensity of the effect of sound upon the aforementioned membranes (and consequently upon the terminal branches of the acoustic nerve) will also be much stronger with a high stand of the barometer than with a low one.

5. *The Ossicles of Hearing.*—Where the vibrations of the air surrounding the membrana tympani on both sides are not too powerful, the ossicles are considered by modern physiologists—and I think rightly—to play the part of a single body, which is intimately united with the aforementioned membrane. To prevent their articular surfaces from gliding upon one another, the hammer and anvil are fitted into one another, according to Helmholtz, in such a way that, in all motions of the membrana tympani inwards, their union will be firm, whilst in the motions of the membrane outwards they may, to a certain extent, be separated from each other. Helmholtz com-

pares this arrangement to the ratchet-wheel of a modern watch-key, which admits of being wound up in only one direction. By means of this arrangement the stirrup is protected from a too violent traction, and the possibility of being torn from the membrane of the fenestra ovalis. In consequence of the intimate union existing between the ossicles, they may be considered as a single two-armed lever, which has its fulcrum at the point where the end of the short process of the anvil rests against the wall of the cavity of the tympanum, its short arm being connected with the membrane of the fenestra ovalis, and its long arm with the membrana tympani. In this connection it must be borne in mind that in man the handle of the hammer is about $1\frac{1}{2}$ times as long as the long process of the anvil, and that therefore the pressure exerted upon the stirrup is $1\frac{1}{2}$ times as great as the force brought to bear upon the handle of the hammer, whilst the excursion of the membrane of the fenestra ovalis in the normal direction is only $\frac{2}{3}$ of that of the membrana tympani. Owing to the fact that this latter membrane can only be stretched so far inwards as to form a very obtuse-angled cone with straight edges (a section of it would have the form *a d b*, Fig. 6), the membrane of the fenestra ovalis is protected from the effects of those strong concussions, which often reach the membrana tympani and ossicles by way of the external auditory canal.

Of the force originally communicated to the membrana tympani, there is lost in the transmission of the motion to the membrane of the fenestra ovalis: (1) that

which is absorbed in the molecular vibration of the ossicles; (2) so much as is necessary to condense the air contained within the cavity of the tympanum; and (3) that which, owing to the resistance of the membranes of the oval and round fenestræ, is expended on the neighboring mass of bone.

As regards the muscles which are attached to the ossicles, nothing more need be said concerning the musculus tensor tympani beyond what has already been mentioned in the section on the membrana tympani. Concerning the musculus stapedius it must be remarked, that its power of changing the position of the stirrup would seem to be for the purpose of voluntarily rendering the sensation of hearing more or less acute, as may be wanted.

6. *The Labyrinth.*—The length of the semicircular canals and *scalæ* of the cochlea is likewise so inconsiderable that the fluid of the labyrinth may be said to vibrate to and fro as a whole. The entire mass of fluid, however, performs its minute pendulum-like excursions in several narrow canals, which all (with one exception) communicate directly with a kind of cistern (the vestibule). While all the rest communicate with the cavity of the tympanum only through this cistern, whose floor (facing the cavity of the tympanum) is closed by the membrane of the fenestra ovalis, this one canal—the scala tympani—is brought in contact with the cavity of the tympanum by means of the membrane of the fenestra rotunda, and communicates on the other hand only through a narrow opening with the tube that is parallel to it (scala vesti-

buli). In a mechanical point of view this is very important, inasmuch as otherwise a motion of the fluid of the labyrinth could not take place.

The transverse and longitudinal vibrations, which are transmitted through the ossicles from the membrana tympani to the membrane of the fenestra ovalis, travel through the entire fluid of the labyrinth about four times faster than in the air, and therefore every phasis of vibration of the membrane of the fenestra ovalis is transmitted, one may say, almost instantaneously to the membrane of the fenestra rotunda. Inasmuch as the fluid of the labyrinth (taking no account here of the membranes contained within it) is incompressible, being surrounded by solid walls, the membrane of the fenestra rotunda will be forced outwards, toward the cavity of the tympanum, exactly in proportion as the membrane of the fenestra ovalis has been pressed inwards, and to the same extent also will the fluid of the labyrinth be displaced from its position of equilibrium. The membrane of the fenestra rotunda being (in proportion to its small superficies) less yielding to pressure, the motion of the fluid has to overcome a resistance which must cause a corresponding pressure upon the membranous labyrinth, and especially upon the lamina membranacea, which forms the wall of separation between the two divisions of the fluid contained within the cochlea—for both of these divisions are under the same atmospheric pressure.

The motion of the fluid commences in the vestibule; that part of it contained within the semicircular canals

must at first remain quiet, because the pressure upon both ends of each of these tubes is the same; only the fluid contained within the cochlea is pushed onward. On the return of the motion, however, the fluid in the semicircular canals (especially in the ends which are provided with ampullæ, and hence offer less friction) will be caused to move at first in the direction of the membrane of the *fenestra ovalis*, for the pressure upon this part of the fluid, which is in the immediate neighborhood of the vestibule or common cistern, is the same as upon the fluid of the cochlea. Owing to the circumstance that the fluid, on its return from the *scala vestibuli*, crosses the stream coming from the semicircular canals, a microscopical eddy is produced, which very probably is able to put in motion the fine sand contained within the little sacks of the vestibule. The participation of the contents of the semicircular canals in this return motion is favored by the circumstance that the *scala tympani* communicates with the *scala vestibuli* only through a narrow opening (*helicotrema*), which indeed cannot offer any obstacle to the propagation of hydrostatic pressure, but can nevertheless retard the motion somewhat by friction.

While, then, this pendulum-like motion of the fluid (within exceedingly small limits of excursion) is repeated in a second, as often as the pitch of the tone requires, the fluid of the labyrinth — being incompressible, but free from every roughness—exerts an increasing and decreasing pressure upon the membranous struc-

tures of the labyrinth, upon which the terminal branches of the acoustic nerve are spread out. That Nature has assigned this office to water, on account of its smoothness and incompressibility, seems to us also to be corroborated by the existence of the peri- and endolymph, surrounding and filling the semicircular membranous canals.

Finally, the shape of the cochlea deserves special mention. It affords in the membrane of Corti a comparatively large surface for the expansion of the terminal branches of the acoustic nerve within a small space; and this surface is subjected to the periodical pressures just mentioned.

III.—The function of the organ of hearing considered as a whole.

To avoid repetition as much as possible, we shall of course leave out here much of what was mentioned in the description of the individual parts of the mechanism of the ear; but the reader will pardon us if we cannot avoid repetitions entirely. They will not be without use, we trust, at a time when so many, as we think, obscure descriptions of the true functions of the apparatus of hearing are in circulation.

The *membrana tympani* is put into a state of periodic vibration by a greater or smaller number (according to the duration of the exciting cause) of waves of condensation and rarefaction, occurring in the neighboring medium (usually atmospheric air), and which for one and the

same tone are perfectly equal. This periodic motion is transferred with the same rhythm, and with but little loss, through the ossicles to the membrane of the *fenestra ovalis*. From here it is transmitted almost instantaneously (in about 0.0001 of a second) to the membrane of the *fenestra rotunda*, causing it to bulge outwards toward the cavity of the tympanum to the same extent as the membrane of the fenestra ovalis is forced inwards toward the labyrinth. The fluid contained in this latter cavity participates in this motion as one mass. On reaching its limit in this direction the motion is then exactly reversed.

This very slight motion, which, as in the pendulum, grows gradually swifter, then again becomes slower, and after a moment of rest goes through the same stages in the opposite direction, starts from the membrane of the fenestra ovalis, goes first in the direction of the *scala vestibuli* of the cochlea, then through the *scala tympani* toward the *fenestra rotunda*; when the membrane of this fenestra has reached its greatest degree of tension the motion is reversed, and passes first through the *scala tympani*, then through the *scala vestibuli*, finally through the semicircular canals, and partly also, by the way of the vestibule, direct to the membrane of the *fenestra ovalis*. Through the crossing of these two streams a small eddy is produced, which causes motion in the microscopical particles of sand contained within the vestibule.

The pressure proceeding from the *membrana tympani*,

and the necessarily equal counter-pressure due to the elasticity of the membrane of the *fenestra rotunda*, are transmitted to the membranous structures contained within the labyrinth, and consequently to the terminal ends of the acoustic nerve spread out on those membranes, the construction of which is peculiarly complicated, and bears some analogy to that of the optic nerve. This pressure grows greater or less in exact harmony (as regards time and intensity) with the waves in the external air, and is accompanied by a simultaneous slight to-and-fro motion of the membranes. The relative slowness not only of the molecular motion caused by the pressure, but also of the last-named undulatory movement, gives to the nerves the requisite time for apprehending and conveying them to the brain.

The nature of the final mechanical effect of the auditory apparatus must be assumed to consist in the oft-mentioned periodical pressures upon the membranes of the labyrinth, since the hearing may yet remain tolerably good even after the continuity of the ossicles has been broken, and consequently the motion of the fluid in the labyrinth stopped.

In the latter case the membranes of both fenestræ (in consequence of the periodically increasing and diminishing pressure made upon them by the air in the tympanum, and also in consequence of consonant vibration, which cannot, however, take place in the form of an actual motion) will produce a periodical pressure on the fluid of the labyrinth, and on the terminal branches of

the acoustic nerve spread out within it. The part played in the auditory apparatus by the *membrana tympani*, in connection with the membrane of the *fenestra ovalis*, is analogous to that played by the cornea in connection with the lens, in the organ of sight. In so far as their superficial expansion will permit, both receive external vibrations—whether of the air or of the ether—in order to transmit them with the strongest possible effect to the terminal branches of the nerve, whose special function is to convey to the brain the corresponding impressions. As regards the mode of accomplishing this effect, however, Nature has followed widely diverging ways in the construction of both apparatuses. In the organ of sight of the higher animals, the chief feature of the action consists in reconcentrating at one point of the distribution of the optic nerve (in order to produce at this point the strongest possible irritation) all the rays which emanate from a luminous point and strike the corneo-lenticular system; but the final effect of the auditory apparatus consists in this, that the rays of sound which reach the internal ear are made to produce the strongest and most uniform effect possible upon the entire terminal ramification of the auditory nerve, which is spread out over a comparatively large surface.*

When we hear music, the above-mentioned periodical pressures produce at the same time, in both ears, a minia-

* This effect is produced here in the same manner as in the hydraulic press, where the amount of pressure exerted upon a comparatively slender column of fluid can be brought to bear with equal intensity upon a surface of almost any size.

ture copy of the music on the membranous structures of the labyrinth, just as when we look at a landscape the rays of light, refracted by the optical apparatus of our eyes, produce a miniature copy of the landscape on the retinæ. If the first could be made as audible as the latter can be made visible,* still the essence of the faculty of hearing, respectively, of sight, would not have to be sought for in these miniature copies; but we must assume that this essence is only to be found in the powerful effect produced by the vibrations of the air or ether (through the assistance of the apparatus specially arranged for this purpose) upon the specifically organized terminal distribution of both nerves of sense.

Helmholtz, that most eminent scientist, to whom acoustics and the physiology of hearing owe so much, is of opinion that the cerebral faculty of perceiving distinctly the several tones is founded on sympathetic vibrations of the individual fibres of Corti, each one of which is tuned to a corresponding tone. Regarding this view, we have to say that we cannot accept the term sympathetic vibration in this connection as meaning the sympathetic vibrations of a string, tuning-fork, etc., which are caused by the simultaneous vibrations of another sounding body of the same nature and pitch. We can only understand it to mean, that for every tone there is a corresponding fibre of Corti's organ, which is supposed to be specially affected by its intonation, and to commu-

* By the well-known experiment of removing a portion of the sclerotic near the posterior pole of the eye.

nicate its own disturbance to a brain fibre with which it is connected.

Our explanation of the final mechanical effect of the auditory apparatus, interpreted in this light, does not in any way conflict with the above-mentioned hypothesis.

As regards the perception of different tones at the same time, we would make the following remarks:—According to Principle 4, the membrana tympani, in its character of a tense, thin membrane, is capable of carrying out at the same moment of time the greatest variety of vibrations. For instance, while it is carrying out the vibration which answers to the deepest tone, it can make the smaller vibrations, and in the midst of one of these, yet other two of only half the size, etc., etc. Moreover, it can even carry out dissonant vibrations at the same moment of time. In all these synchronous vibrations the handle of the hammer takes part, and transfers them to the membrane of the fenestra ovalis, from which they are transmitted through the fluid of the labyrinth to the terminal branches of the acoustic nerve; the transverse vibration on the membrana tympani being probably changed into horizontal by the pendulum-like vibrations of the stirrup.

A few remarks may be permitted in regard to the relative dimensions of the individual parts of the auditory apparatus.

If the cavity of the tympanum, whose essential function is to afford the *membrana tympani* free motion, were smaller, then too much force would be absorbed

through the condensation of the air contained within it; if it were greater, then, as we have said before; a disturbing resonance would occur in the case of the high tones.

The wave length of B, in water, amounts to $\frac{1453}{3960}$ metres $= 367^{mm.}$ If we estimate the length of the distance from the membrane of the fenestra rotunda through the scala tympani, the scala vestibuli, the vestibule, and the longest semicircular canal at $63^{mm.}$, then it would amount to more than $\frac{1}{6}$ of the aforementioned wavelength. From this it can be seen that the passages of the labyrinth could not be much longer without disturbing the uniform motion of the particles of water.

If the ossicles were considerably larger, it would be more difficult for them to come to rest, or to be put in motion again, than seems best. Were the membrana tympani much greater, it would be too apt to tear, or too clumsy.

The proportions of the individual parts of the auditory apparatus are dependent on a constant factor, the outer atmospheric air; therefore their absolute dimensions cannot vary much.

It is for this reason, too, that in the most different varieties of mammifers, the formation of whose skulls often deviates so much from our own, the individual elements of the organ of hearing differ but slightly from those of man. For the same reason, also, these elements in the child are but little different from what they are in the adult.

Among the authors who have written on this subject, Chladni is the one to whose opinion our interpretation

of the final mechanical effect of the auditory apparatus comes nearest. He says (page 329 of his "Traité d'Acoustique"): "The vibrations which are communicated to the two fenestræ of the labyrinth affect the entire mass of water contained within it; for, as in general, every pressure exerted upon a fluid is extended to the entire mass in such a way that every molecule of it feels the same pressure. It can therefore be assumed that this pressure is exerted upon the entire nerve substance contained within the labyrinth; and it is not in harmony with nature to maintain that every tone affects only certain parts (of the nerve substance). These impressions upon the entire substance may, however, take place in an endless variety of ways; and if several tones are heard at the same time, all the vibrations necessary for this purpose will occur at the same time without interfering with one another, as it is the case with (molecular) motions in general. The labyrinth appears to be constructed in this complicated manner in order that all kinds of impressions may be produced with the greatest facility."

CORRECTION.—In my paper on binocular vision, in the first number of these Archives, there occurred to me a slip of the pen, which I beg leave to correct here. From the statement on page 188, line 14, etc., it would follow that the angle of wheel-rotation is o when the point of fixation lies in the median plane. This is incorrect (see my paper on the Horopter, in Graefe's Archives, XV., 1, pages 123 and 126). This angle, on the contrary, is o, as follows from the quoted formula of Listing, when the visual line of the eye is parallel with the median plane, or, in vertical position of the head, horizontal.

THE DIAGNOSIS OF INTRA-OCULAR SARCOMATA.

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(WITH CHROMO-LITHOGRAPHIC PLATES A AND B),

(Translated from the German by E. GRUENING, M.D., of New York, Assistant to the New York Ophthalmic and Aural Institute.)

At the meeting of the Ophthalmological Congress, in the year 1868, at Heidelberg, a discussion arose with reference to a paper on choroidal sarcomata, by Prof. Knapp, between the latter and Dr. Wecker, of Paris, whether the commencement of sarcoma is complicated with detachment of the retina, as Dr. Wecker asserts, or, whether tumors may remain in contact with the outer surface of the retina during a certain period of their development, which opinion Dr. Knapp seems to advocate. Von Graefe considered both—the presence of retinal detachments and their absence during the first stage—to have been proved by observation. According to his experience, however, detachment of the retina occurs in the majority of cases. He had but rarely had the opportunity of examining with the ophthalmoscope small choroidal sarcomata in the fundus of the eye, whilst it happened to him several

times in every year that a choroidal tumor escaped his notice under the disguise of a detachment of the retina, or that a suspicion of its existence was excited only by other reasons. He added, that the difference of location of the tumor with regard to the veins might possibly explain why, in some cases, serous effusion set in at an early period, whilst in other cases it was wanting.

Whilst in text-books of ophthalmology, as well as in illustrated works on ophthalmoscopy, detailed statements on the diagnosis of commencing choroidal tumors are missing, so that we must rely on the expositions of Von Graefe (Archiv für Oph., 1, 2, p. 233), Dr. Knapp endeavors in his book on Intra-Ocular Tumors, p. 249, etc., to treat more thoroughly of the diagnosis of choroidal sarcoma. In this treatise he traces the four stages which he ascribes to the sarcoma of the choroid. These stages are the following:—1. Development of the primary sarcomatous intumescence of the choroid without noticeable symptoms of irritation in the eyes. 2. Presence of inflammatory symptoms in the globe resembling glaucoma. 3. Extension of the pseudo-plasm to the surroundings of the eye-ball. 4. Generalization of it by way of metastases in other organs. Omitting both the latter stages, a separation of which may not always be possible, I only repeat what has been written on the diagnosis of such tumors in their second and first stages. I have already mentioned that the principal difficulty in the diagnosis of choroidal sarcoma lies in the detachment of the retina, which nearly always accompanies the tumor.

To Prof. Von Graefe is due the merit of having pointed out that behind retinal detachment, in all probability, a tumor is concealed whenever increase of intraocular pressure and ciliary neurosis supervene. (A. f. O., IV., 2, p. 211.)

We know at present that on the one hand tension may be exceptionally increased in simple detachment of the retina, whilst on the other hand it may every now and then be diminished even in sarcoma of the choroid. Dr. Knapp (l. c., p. 251) enters minutely into the details of the differential diagnosis of tumors, glaucoma, and other affections with which a limitation of the visual field is connected.

The differential diagnosis of the first stage of choroidal sarcoma, of which I intend at present to speak, has likewise been treated most thoroughly by Prof. Knapp, although it must be conceded that Von Graefe's remarks on the subject have not been surpassed. I therefore beg leave to republish his so-frequently quoted words, since they will constitute the starting-point of our considerations.

"As regards the first development of sarcoma of the choroid, I have gradually arrived at the conviction that the early appearance of serous inflammations of the retina forms the rule. Therefore, with the exception of tumors in the region of the ciliary body, it will hardly be possible, ophthalmoscopically, to diagnosticate the first commencement of a choroidal sarcoma; we will rather, in the beginning of the affection, have a simple detachment of the retina before us; may perhaps have some re-

mote suspicion from the absence of the causes usually producing the same (scleral staphyloma, affection of the vitreous, inflammatory processes, hemorrhagic extravasations, scleral cicatrices), but to diagnosticate with certainty in this stage can hardly be thought of."

Suspicious rigid lumps, occasionally pigmented, do not come into view until in the course of the development of the growth the retinal fluid becomes more and more dis placed, and the mass of the tumor again approaches the retina. The appearance of those lumps, in addition to floating portions of the retina, rouses the above-mentioned suspicion, the probability of which becomes heightened when, with the advancement of the tumor, the intraocular pressure progressively increases.

In this very exposition Von Graefe points out a difference, with regard to the accompanying detachment of the retina, between such tumors as take their origin from the ciliary region and such as spring from portions of the choroid lined with the retina. The former may, at a later period, give rise to a retinal detachment; still, this casualty does not happen so readily, on account of the pars ciliaris retinæ having a far more intimate connection with the uvea than the retina proper with the choroid. In the discussions of the Ophthalmological Congress of 1868, Von Graefe, however, conceded, as mentioned above, the possibility of the development of choroidal tumors without subsequent detachment of the retina.

The number of choroidal sarcomata in my pathological

collection amounts to sixteen, four of which confine themselves to the bulb of the eye, while three of them have altered the shape of the bulb without perforating the sclerotic, and the remaining nine have wrought intimate connections with the surrounding tissues. I had an opportunity of observing three of these tumors in their first stage (according to Knapp). In a living person I have never met with a choroidal sarcoma originating in the ciliary body. There are, however, three cases among those enumerated above, which, relative to the manner of their first appearance and total development, deserve, in my opinion, a special clinical consideration. I speak of sarcomata taking their starting-point exactly in the region of the macula lutea, where they can be observed and examined ophthalmoscopically in the first stage of their evolution. These tumors must needs be considered completely intraocular, since there is neither an impediment in motility nor a projection of the bulb discoverable.

1. The first case of this kind came under my observation in 1865. A short time after I had found the first intra-ocular cysticercus in Vienna, Dr. Tetzer consulted me with regard to one of his female patients, who, in the posterior pole of the eye, exhibited a retinal projection behind which a cysticercus was suspected. The woman was forty and odd years old, in good health, and in a state of vigor corresponding to her age. The transparent media of both eyes were clear. In the left eye I found in the region of the macula lutea a round white spot, of four times the size of the papilla, without well-marked edges, and traversed by dilated vessels. It projected to such a degree as to bring distinctly into view the summit of the prominence by means of a convex lens No. 10, the fundus being plainly discernible without cor-

rection by an emmetropic eye. The general aspect of the arrangement of the vessels bore a resemblance to the well-known retinal injection. It was striking that in a situation where by the aid of the ophthalmoscope generally no vessels can be perceived, a plainly developed vascular system had formed. At that time I examined the woman repeatedly in the course of several weeks. Not being able, however, to trace the outlines of a vesicle behind the retina, and there being neither phenomena of motion nor an increase in size perceptible, we dropped our supposition of cysticercus and suspended the diagnosis.

The visual disturbance of the patient consisted in a central defect of the field of vision, corresponding strictly to the projection perceived by the ophthalmoscope. Eccentric vision was nearly as good as in the healthy right eye.

Two years subsequently, Dr. Tetzer having died in the mean time, I assisted Prof. Arlt in the enucleation of an eye in a case of orbital tumor connected with the bulb. I was greatly surprised to recognize the patient as the identical lady whom I had previously examined. Dr. Tetzer being dead, it is impossible for me to communicate anything concerning the further development of this highly interesting ophthalmoscopic appearance, the patient, according to my knowledge, only having been under the observation of Prof. Arlt a short time prior to the operation. When I first met the patient again, immediately before the operation, I found a very considerable exophthalmus, the cornea intact and clear, the lens transparent, but the vitreous body so turbid that the fundus could not be perceived. Visual power was totally extinct.

We succeeded in removing the bulb, together with the neoplasm, without cutting into the latter. Fig. 1 is a 4-in. diagram of the horizontal section. It shows, first of all, that the optic nerve, cut more than half an inch behind the bulb, exhibited a completely healthy appearance in its larger posterior portion. Interrupting the description of the diagram, I may add that the patient, in spite

of the tumor having been successfully enucleated, and the optic nerve cut at a considerable distance from the bulb,

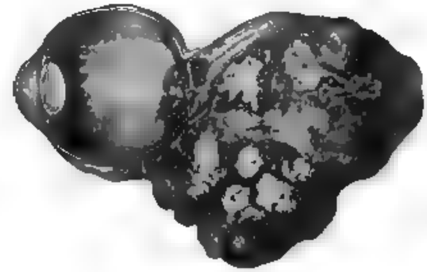

FIG. 1.

died a few months subsequent to the operation, without manifesting, if I remember well, a local recurrence of the affection. In the autopsy numerous melanotic sarcomata were found in nearly all the abdominal organs, but chiefly in the liver. The microscopical examination of the tumor revealed a sarcoma consisting of fusiform cells of extraordinay size. The shaded parts of the diagram were richly pigmented, while the light portions presented, in the fresh section, a pale-yellow appearance, and contained little or no pigment at all.

The appearance of the tumor in the interior of the eye is really striking. The vitreous body is intersected by membranes, which, viewed by the microscope, are found to consist of very fine ramified cells. The retina is everywhere in contact with the choroid, excepting in the regions of the optic nerve and macula lutea, where it is raised by a flat elevation. This prominence is occasioned by a

black pigmentary mass, which, as the diagram demonstrates, consists of two small, isolated lumps, breaks through the sclerotic in the region of the macula lutea, and passes posteriorly into the tumor situated on the outside of the optic nerve. It is obvious that the blindness depended upon the proliferation of the neoplasm into the optic papilla. The retinal projection observed two years prior to death was caused by a relatively small portion of the tumor rising internally beyond the normal level of the choroid. It is a very surprising fact, that a neoplasma having taken its origin in the interior of the eye, and perforated the sclerotic, should externally attain the size of a pigeon's egg, and internally grow but inconsiderably in the course of two years. With a great degree of probability we may assume that, at the first examination, there existed no growth on the outside of the globe. Estimating the size of an intumescence which, two years ago, would have produced the then observed degree of retinal projection, we must concede that the tumor could hardly have been of much greater size than that of the dead eye under consideration.

2. Several weeks subsequently, a man, complaining of bad sight in his right eye, presented himself in the Clinic of Prof. Arlt. The eye exhibited the so-called glaucomatous condition, but with a central defect of the visual field and peripheral perception of light everywhere. It was impossible by an ophthalmoscopical examination to perceive the fundus of the eye clearly, on account of numerous opacities in the vitreous humor. We succeeded, however, in detecting a retinal prominence of moderate size, exactly in the region of the posterior pole. We

could discover no vessels, neither active nor passive motions; and since primary glaucoma could be excluded, we were led by the increased tension to infer, with some degree of probability, the presence of a tumor. Enucleation was proposed, but rejected by the patient.

FIG. 2.

On the 29th of September, 1868, I recognized in the clinic of Prof. Billroth, of Vienna, this very patient from whom an orbital tumor of the size of an apple had been removed. Fig. 2 represents a section of the tumor. The cornea is destroyed, and has given issue to the lens; the shape of the globe is pretty well preserved. In the region of the posterior pole we find a tumor, which has consumed the choroid, raised the retina, and perforated the sclerotic. The optic nerve is relatively well separated from the mass of the tumor, and contains but few sarcomatous elements in different spots. Externally the tumor had assumed extraordinary dimensions, occupying during life not only the whole of the orbital cavity, but also proliferating beyond it, and forcing the remains of the globe forward.

In this specimen we meet likewise with the very strik-

ing fact that a tumor, springing undoubtedly from the interior of the globe, exhibits there a relatively insignificant development, while, after breaking through the sclerotic, it attains externally very considerable dimensions. It also deserves special mention that, in this case as in the former, the neoplasma originated exactly behind the macula lutea.

The microscopical examination revealed a sarcoma consisting of small round cells. The case is the same reported by Billroth (Chirurgische Klinik, Wien, 1868, p. 35). There it is stated: "The tumor, situated between the bulb and the muscles, had enclosed the former completely, without having grown beyond it. Fig. 2 demonstrates that the last statement is not fully correct. The patient had a recurrence of the affection in the orbit on the 15th of May, 1869.

3. On the 21st of October, 1869, I was consulted by Sister Ph., of the convent at Niederbrunn, Alsace. She stated that she had lost central vision in her right eye several weeks ago. The dark spot had been small in the beginning, but it gradually extended in size, and vision is at present much deranged, even when both eyes are kept open. The examination revealed a complete state of health of the anterior structures of the eyes, and transparency of the optic media. In the region of the macula lutea I could perceive, ophthalmoscopically, a whitish prominence, of an oval shape in the transverse direction, and consisting of two protuberances of different size. The surface of the elevation presented a hazy appearance, the retinal vessels were dilated, and my attention was chiefly called to a wide vein which advanced to the centre of the macula lutea, and there became lost in the tissue. In this situation there are certainly no vessels visible in

normal eyes. The edges of the tumor were gradually sloping towards the level of the retina, and the retinal vessels were seen to wind their course up the tumor without any interruption whatever. No interval could be perceived between the tumor and the retina.

Examining the functions of the eye, I found, instead of direct vision, a completely well circumscribed defect of the visual field, while peripheral vision had remained unaltered.

I made the diagnosis of choroidal sarcoma at once, reserving, however, my statement till I would have perceived a distinct increase in size within a relatively short space of time. I determined upon an operation as soon as I had succeeded, by repeated examinations, to discover through the somewhat opaque retina, and in the mass of the tumor, numerous extraordinarily pale vessels, lying in close vicinity to each other. I considered these to be newly formed vessels, because I had not detected them previously, even by very careful inspection. My view was rather corroborated by the fact that the arrangement of these vessels neither corresponded to the conformation of the retinal nor of the choroidal vessels. Immediately after the enucleation I made an equatorial section of the bulb, and had the specimen drawn. (Fig. 3.) The section passed through the tumor, perceived ophthalmoscopically in the region of the macula lutea, and hit rather peripherally upon another small sarcomatous lump, to which the retina was also closely adherent.

In these three cases, in which I had an opportunity of examining choroidal sarcomata with the ophthalmoscope,

in the incipient stage of their development, the tumors had already grown to such an extent as to injure sight

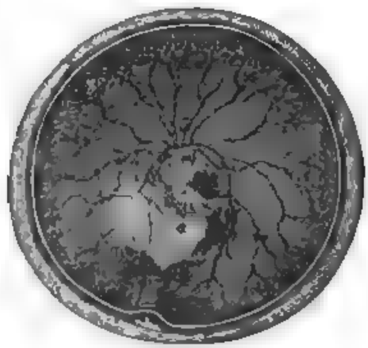

Fig. 8.

considerably, and yet no trace of retinal detachment existed; on the contrary, both specular examination and the anatomical specimen demonstrated the immediate contact of the retina with the tumor.

I am obliged to state, that the eyes were examined ophthalmoscopically during a relatively short period of time in the evolution of the growth. With regard to the first two cases I must concede that, concerning the point in question, I have to rely upon my memory, not having taken notes at the time of observation. One would also be of opinion that my attention had not been called to this very subject at that time, on account of the controversy not having been raised yet. As regards the last case, however, I maintain the indisputable fact, that the specular examination admitted of no other inference but that the retina was as inti-

mately connected with the tumor as with the choroid laterally.

While ophthalmoscopical examinations did not prove sufficient to settle the point in question in all three cases, the anatomical investigation was more conclusive. In the first and third specimens, the retina lies in immediate contact with the choroidal sarcoma, although the third case represents a recent tumor, and the first a growth of several years' standing.

I admit, of course, that these cases differ from the ordinary form of sarcoma. A choroidal sarcoma existing any length of time and advancing toward the vitreous body assumes rapidly, if not from the very beginning, a more or less globular shape; but the tumors under consideration project but inconsiderably, and do not rise steeply: they are flattened, and overlap the choroid to a less degree. The physical conditions hence favor a more permanent contact of the retina with its substratum. These tumors differ, furthermore, from ordinary sarcomata in the fact of their being situated in the posterior pole of the eye.

Von Graefe admits that sarcomata springing from the ciliary body form an exception with regard to their relation to the retina. This circumstance depends upon the more intimate regional connection of the retina with its substratum. An analogous condition exists in the region of the macula lutea. It is well known that choroidal veins are but exceptionally given off from that part of the eye, and this very circumstance might add to explain why

sarcomata, forming in that region, remain, during the period of their growth, constantly in contact with the retina without giving rise to its premature detachment.

But even choroidal sarcomata not springing from either of the mentioned regions may, in some rare cases, exhibit, during the whole time of their development, either a very small quantity of fluid or none whatever between the tumor and the retina. In these cases the diagnosis of choroidal sarcoma can be made even solely from the shape of the retina, which has become forced into the vitreous body. I shall endeavor to substantiate this assertion by several cases that came under my observation.

4. In June, 1866, Th. B——, who three years previously had been operated on for cataract with a very good result, by Prof. Arlt, and since then had been able to pursue with the operated eye the calling of a country-town teacher, presented himself at the clinic, complaining of a diminution in sight of recent date. Examining the patient, we found good central vision, while the lower and inner part of the visual field presented a very considerable defect. Corresponding to this limitation of the field of vision, the ophthalmoscope revealed, in an upper and outer situation, an almost globular mass covered by the retina, and projecting into the pupillary space. The retina did not exhibit the ordinary blue color usually found in cases of excessive detachment; neither characteristic folds nor oscillations upon moving the eye could be detected. The vessels were neither of brown nor black, but of normal color. None but retinal vessels were to be discovered. Inspecting the surroundings of the tumor, we saw the fundus of the eye clearly and distinctly, the vitreous body being completely transparent. The papilla was readily brought into sight, and it was found that, at a short distance from it, the retina was slightly detached toward the tumor.

Bringing into focus the vessels situated at a short distance behind

the lens and upon the surface of the tumor, one could everywhere pursue their course back to the edge of the convex mass, and convince one's self of the posterior direction which they took. Examining alternately the direct and the inverted images, and combining the latter method with the manipulation of producing prismatic displacements by means of lateral movements of a convex lens, one was almost forced to the conclusion that posteriorly the tumor diminished in circumference, thus constituting a pedunculated growth. As mentioned above, no pouch of detached retina could be detected anywhere, and we even argued that the retina was posteriorly more or less firmly adherent to the peduncle of the tumor. A simple serous detachment of the retina can never assume this form, and I am therefore of opinion *that the diagnosis of choroidal sarcoma can be founded upon the existence of a tumor of that shape.*

We resorted to a probatory retinal puncture through the vitreous body. The tumor bled freely, but did not collapse. The patient, not consenting to have the eye enucleated, left the clinic. Three months subsequently he returned, with his eye in a glaucomatous condition. An iridectomy was performed, but failed to relieve the pain. When we finally enucleated the eye, the tumor had already broken through into the orbit. Three months subsequent to the operation the affection recurred, compelling us to remove completely the contents of the orbit. Though this was readily done without leaving behind parts of the tumor, the patient was not benefited by it, but died of apoplexy the next day. The microscopical examination revealed a choroid sarcoma consisting of large cells, and containing but a trifling quantity of pigment.

5. I met with a very similar case in the person of the steward, C. F——, of Leesdorf, near Baden. The ophthalmoscopic appearance was so analogous to that of the preceding case that a description would merely constitute a repetition, and I shall simply mention that, in this case, I was able to perceive through the retina several branches of a vascular system situated upon a posterior plane, and showing an unusual arrangement. The diagnosis could be readily based upon this very sign. It was rather striking that two years subsequent to the first examination

the eye was found free from pain and increased tension. I am unable to give a further account of the history of this case, as I lost sight of the man in consequence of my departure from Vienna.

In the following case my observations were more complete.

6. L. R——, clerk, æt. 28, enjoyed good health up to March, 1867. At that time he noticed that his sight became impaired without an assignable cause; he was, however, free from pain. At the end of March he consulted a renowned ophthalmologist of Vienna, who instilled atropine, and, after examination, proposed to puncture the detached retina; the patient did not consent to have it done, but called on me. On examination I found the very details of both the preceding cases. The patient read Jäger No. 4 at five to seven inches; acuteness of vision being $\frac{20}{50}$. The state of refraction was emmetropic, and the left eye completely healthy. I admitted the patient for observation to the ophthalmic clinic, where he remained three weeks. The diagram of Plate A was executed immediately after his admission, and gives a far better idea of the then observed ophthalmoscopical appearance than a detailed description. A pedunculated globular mass, situated closely behind the lens, and covered by the retina, projected from outwards so far toward the visual axis of the eye that the region of the macula lutea could just be examined. Nothing abnormal was found in the papilla and its vicinity. On the surface of the tumor the large retinal vessels were distinctly perceptible, several of them with extravasation spots along their walls. Looking at the centre of the tumor, it appeared of a whitish, pale-red color, while its extreme limits presented a blue color. Employing the mirror in different foci, I came to the conclusion that another circular outline could be discerned on a somewhat posterior plane behind the detached retina. The retina, hence, was separated from the tumor beneath by a thin layer of fluid. Plate B shows this condition very distinctly. It was sketched four weeks subsequently, the tumor in the mean while having undergone considerable changes.

In this case I first employed a method of examination not yet mentioned in text-books of ophthalmoscopy. By that method the highest possible magnifying power of the ophthalmoscope is obtained. In high degrees of hyperopia, the size of the image bears a direct ratio to the power of the retrospecular lens employed. The nearer, in a given case, the observed eye is approached, the stronger the convex glass ought to be. If the latter be adjusted behind the mirror, this instrument must be held at a distance of at least two inches from the eye. An additional approximation can only be attained by holding the convex glass between the mirror and the eye. Thus it becomes possible to employ the lens at a distance of a few lines from the anterior principal point of the eye. The increase in size attained is the greater the more the correcting glass approaches the eye, the power of the employed convex lens increasing in the same ratio.

By this method I succeeded in perceiving in and behind the retina alterations which whould have escaped my attention. The hemorrhagic spots of the retina were gradually absorbed, but behind them several red bands with well marked outlines, and characterized by their anastomoses as vessels, became visible. The latter are represented on Plate B, behind the narrow filiform retinal vessels, as considerably wide anastomosing bands, of a uniformly red color. In their course they neither exhibit a resemblance to retinal nor choroidal vessels, and are therefore to be considered as newly formed, and belonging to the neoplasm.

The diagnosis was thus settled, and there existed no doubt as to the course to be pursued. The patient refused to have enucleation performed at once, and was therefore discharged from the clinic, and advised to return as soon as the eye became painful. On the first of December, 1867, the patient submitted to the operation after having suffered from pain for eight days. The eye had passed into the so-called glaucomatous stage. The neoplasm, examined microscopically, was found to be a choroidal sarcoma.

A few weeks ago I wrote to the patient, and he informed me that at the present time, winter 1869–'70, two years after the operation, he enjoyed good health, the affection not having recurred.

7. As a curious fact I will mention, that the very day I have been writing this paper, February 25th, 1870, I was consulted by a farmer, aged 58, of the neighboring village of Pl., whose right eye presented the very same aspect described in the three preceding cases. A globular mass, covered by the retina, projected into the pupillary space of the right eye. Employing the mode of examination mentioned above, a neck-like constriction could likewise be demonstrated posteriorly. A convex lens, brought as near to the eye as possible, did not only render visible the capillaries of the retina, but also behind the latter, and on a posterior plane, the newly formed vessels of the tumor. The extreme sharp edge appeared of a somewhat bluish color, which admitted of the inference that a very thin layer of serous fluid was situated between the retina and the tumor. This diagnosis admits of no doubt, the very vessels of the tumor being perceptible. But even if no vessels could be seen, I would not have hesitated to diagnosticate a choroidal tumor from the peculiar shape.

Basing upon my own observations communicated in

this paper, and upon the remarks of other observers, I consider myself entitled to assert, that it depends upon the situation of a choroidal sarcoma whether it can be distinguished with certainty, and at an early period, from a detachment of the retina.

I. It has been asserted by Knapp (l. c.), and conceded by Von Graefe, that a sarcoma, taking its origin from the ciliary body, can remain in contact with the retina during the whole period of development and still be diagnosticated; since the occurrence of retinal detachment cannot take place in this situation, in consequence of the intimate connection existing between the pars ciliaris retinæ and the corpus ciliare. In a special case Knapp had an opportunity of demonstrating the existence of a choroidal tumor by the fact that the latter, in its growth, tore the iris from its ciliary attachment.

II. Choroidal sarcomata originating (as cases 1, 2, 3) in the region of the macula lutea, seem from the very beginning to have but little disposition to proliferate in the interior of the eye, but are prone to develop posteriorly in the orbit. Both of those cases, at least, which I had an opportunity of observing during a certain period of time, remained stationary in the interior of the eye, at a relatively inconsiderable phase of their development. As minutely stated above, it probably depends upon anatomical conditions, that in this situation the retina never becomes detached from the tumor by a serous effusion. *And thus it seems to be proved that choroidal sarcomata really do exist during a cer-*

tain length of time without the supervention of retinal detachment.

III. In the aspect of choroidal sarcomata of a more advanced stage a marked difference presents itself, depending upon the upper, lower, or lateral intra-ocular origin of the tumor. It cannot be denied that in these cases the retina has nearly always been found somewhat detached from the growing tumor by a serous effusion. But the cases which I reported have not been observed in the first stage of their development, and we will but rarely have an opportunity of examining such cases, since choroidal sarcomata of small size, and developing peripherally, produce no functional disturbance, and can only be detected by chance. If a tumor of this description be located in the lower half of the globe the serous effusion will spread on all sides, while the retina remains in contact with the summit of the tumor. The whole will therefore present the aspect of a more or less projecting retinal detachment with a broad base. Should the case finally become accessible to observation, on account of functional disturbances, it will depend upon accompanying phenomena, as turbidity of the vitreous humor, etc., etc., whether the small point of adhesion between the retina and the tumor is detected, and vessels are perceived. Without seeing the latter it would be impossible, in the first stage of development, to distinguish between a detachment of the retina and a tumor. A sarcoma developing from the upper wall of the globe will likewise only by accident come under observation in

the first stage of its development. The tumor will also, in this region, occasion a serous effusion, but the gravitating fluid will collect around the tumor in a different manner. The retina, forced by the neoplasm in a direction from above downwards against the vitreous humor, forms a vertically suspended pouch. It is easily understood that in this situation of the tumor, the base of the latter shows either a very inconsiderable retinal detachment or none at all, while serous fluid, collecting in a retinal pouch, surrounds the body proper of the neoplasm and reproduces the particular shape of the tumor. In accordance with this observation, such choroidal tumors as originate exactly from the centre of the upper wall show no trace of retinal detachment at the base, while in a lateral situation the retina never fails to become somewhat detached.

It depends upon the quantity of fluid found between the tumor and the detached retina whether the former can or cannot be perceived through the retina. If the former be the case, the diagnosis becomes indisputably settled. Should neither vessels nor another outline be discernible behind the detached retina, the shape of the latter, reproducing the outlines of the tumor, will indicate the presence of choroidal sarcoma.

It furthermore deserves special consideration that upon the surface of choroidal sarcomata which, in the course of their growth, advance their summits near to the visual axis, a development of vessels can be observed. In case 6 I had an opportunity of pursuing from day to

day, and occasionally from hour to hour, the gradual presentation of a widely reticulated vascular network belonging to the choroidal sarcoma. According to Von Graefe's statement, mentioned above, this phenomenon could be explained by the reapplication of the retina in the course of the further development of the sarcoma and the absorption of the effused fluid. My observation in case 6 tends to maintain that vessels situated on the surface of the tumor develop with particular energy only at that period. Cases 5 and 6 demonstrate that in this phase of development the tumor occasionally exhibits a temporary cessation of growth, during which period we might imagine its inner organization, upon which the formation of superficial vessels depends, becomes more complete.

In case 6 I observed that in the beginning the vessels were wide and faintly limited, analogous to embryonic vessels, but subsequently became metamorphosed into a regular vascular network with well-defined outlines. It even seemed that, in one place, well-defined vessels had gradually been forming in a red spot, bearing the appearance of extravasated blood. The close approximation of the intumescence to the posterior nodal point of the dioptric system, affording great accuracy of examination, should have rendered it possible to observe that the distance between the retina and the surface of the tumor decreased at the rate of the progressive absorption of the fluid effusion. But such changes I did not recognize.

A PRELIMINARY NOTICE ON THE ANATOMY AND PHYSIOLOGY OF THE EUSTACHIAN TUBE.

BY PROF. MOOS.

Translated by Albert H. Buck, M.D.

AN article published by Prof. Rüdinger in the April number of the Monatschrift für Ohrenheilkunde, 1869, compels me, against my original intention, to make the following brief communication.

The investigations which I commenced a year ago in the institute of Prof. Julius Arnold, and have carried on ever since, led me to the belief that the Eustachian tube is closed beyond the ostium pharyngeum. In those cases where the peculiar shape of the cartilage requires it (in man, in cows, and in oxen), the closure is effected by a peculiar cone-like intumescence of the mucous membrane. In others, the thickness of the mucous membrane alone suffices to effect a closure. This cone-like intumescence in the ox and cow, which hitherto has escaped the notice of the authors who have studied this subject, gains a new physiological interest from the fact that in the calf it is entirely wanting. The above results

were obtained on Eustachian tubes of men and animals, prepared according to different methods.

In order to preclude future discussions as to whether my investigations were independent of the published statements of others, I must say here that the preparations demonstrating these points were shown last autumn to Prof. Julius Arnold, to Prof. Simon, and to Dr. F. A. Pagenstecher, in the Heidelberg Pathological Institute. In November, 1868, I communicated to Prof. Helmholtz these same results relative to the closure of the Eustachian tube when in a state of rest, and mentioned especially the cone-like intumescence. Already in August, 1868, I sent preparations illustrating this point to Dr. Politzer, in Vienna, and wrote to him my belief that the Eustachian tube in a state of rest is closed. On the 26th of March, 1869, moreover, during my stay in Munich, I discussed this very topic with Prof. Rüdinger (who, until quite recently, as is well known, held the opposite opinion), and expressed to him my belief that the Eustachian tube is closed in a state of rest, and that in man the closure is effected by a cone-like intumescence of the mucous membrane.

HEIDELBERG, May 29, 1869.

NOTE 1.—The above preliminary notice appeared in the first number of the German edition of these Archives, in July, 1869, when the print of the English edition was already completed.

NOTE 2.—In the note at the end of the article (Vol. i., No. 1, p. 9, of these Archives) entitled, "Entoptic Phenomena Connected with the Circulation of the Blood," for Strabismus *Externus*, read Strabismus *Internus*.

H. KNAPP.

EXPLANATION OF PLATES.

PLATE I.—*Vertical section through the Stirrup.*

THE base of the Stirrup (C) lies between the lower (A) and upper (B) borders of the fenestra ovalis. *a* corresponds to the side turned toward the tympanum, *b* to that facing the vestibule. The lower end, *c*, is somewhat more flattened than the upper, *d*. On its inner or vestibular side the base of the Stirrup is cartilaginous, whilst toward the tympanum it consists almost entirely of bone. The margin of the fenestra ovalis is also cartilaginous. A band, *e*, of connective tissue, rich in nuclei, stretches from the border of the base of the Stirrup to the opposite margin of the fenestra ovalis. On the vestibular side the base of the Stirrup is covered by a fibrous membrane, *f*, or periosteum. Toward the tympanum it is covered by a similar membrane, which, in the drawing, is only visible at *g* near the margin. 25 diameters.

PLATE II.—*Horizontal section through the Stirrup.*

(Only the ends of the base C are given in the drawing.) Toward the cavity of the tympanum *a'* the base of the Stirrup consists almost entirely of bone; toward the vestibule *b'* there is a peripheral zone of cartilage. The anterior end A is rounded, whilst the posterior B is flattened; both are cartilaginous at the periphery. Toward the cavity of the tympanum, as well as toward that of the vestibule, the base C is covered by a fibrous membrane. *d* represents the tense band of connective tissue which stretches from the margin of the fenestra to the opposite border of the base of the Stirrup. 25 diameters.

The colored plates A and B represent the ophthalmoscopic appearances of a case of *Choroidal Sarcoma*, a detailed description of which is to be found on pages 710 and 711 of this volume.

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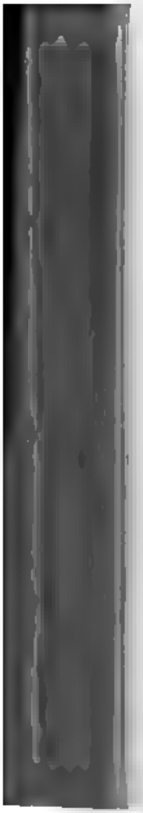
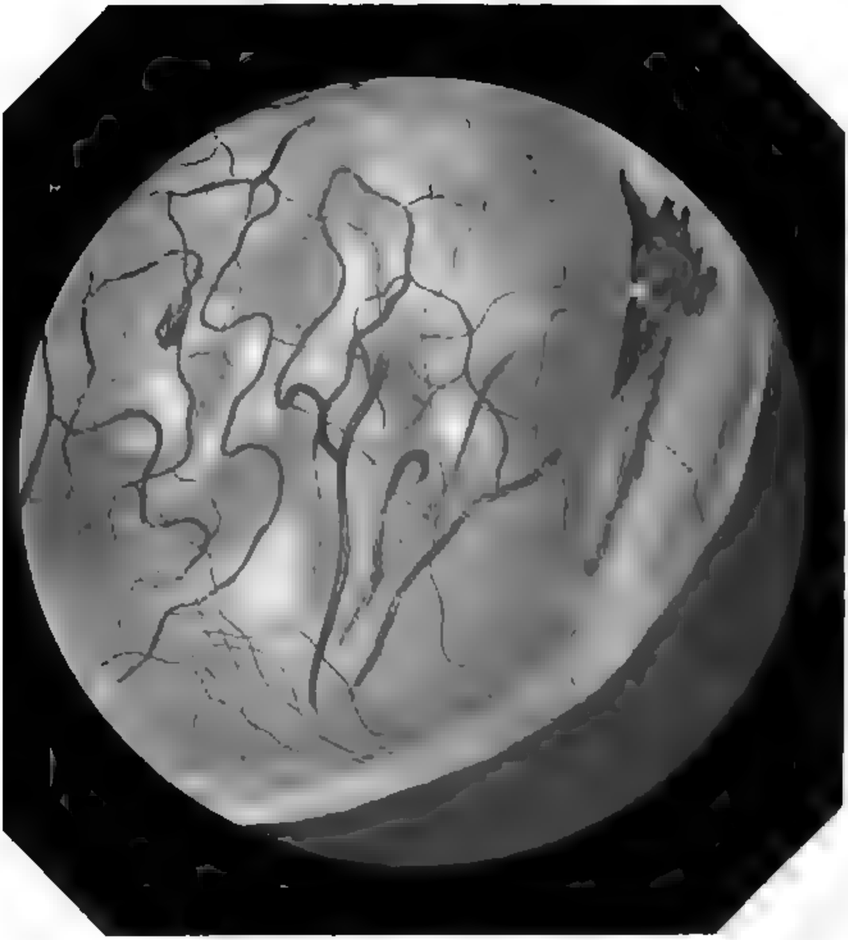


Tab. B.



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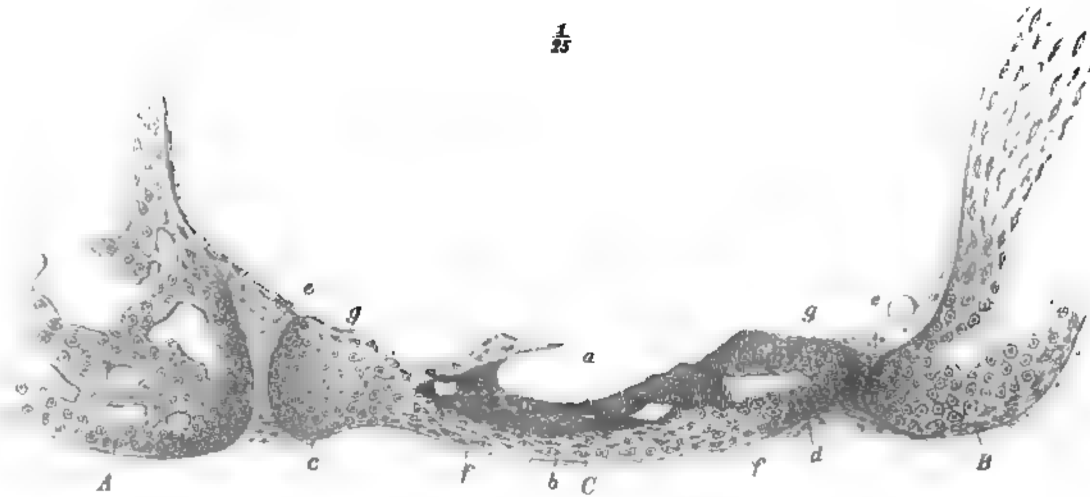

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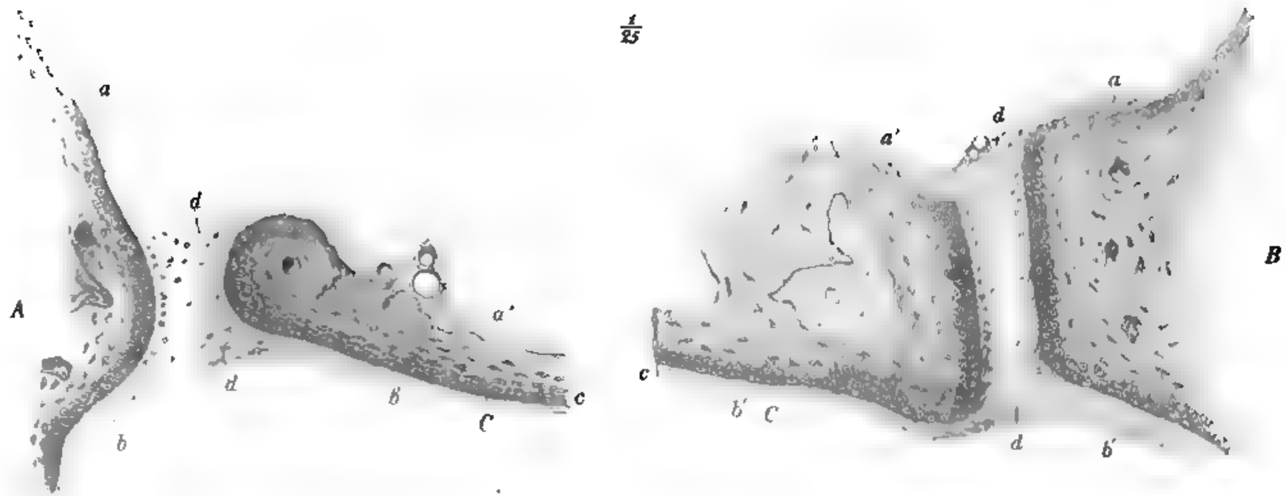

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